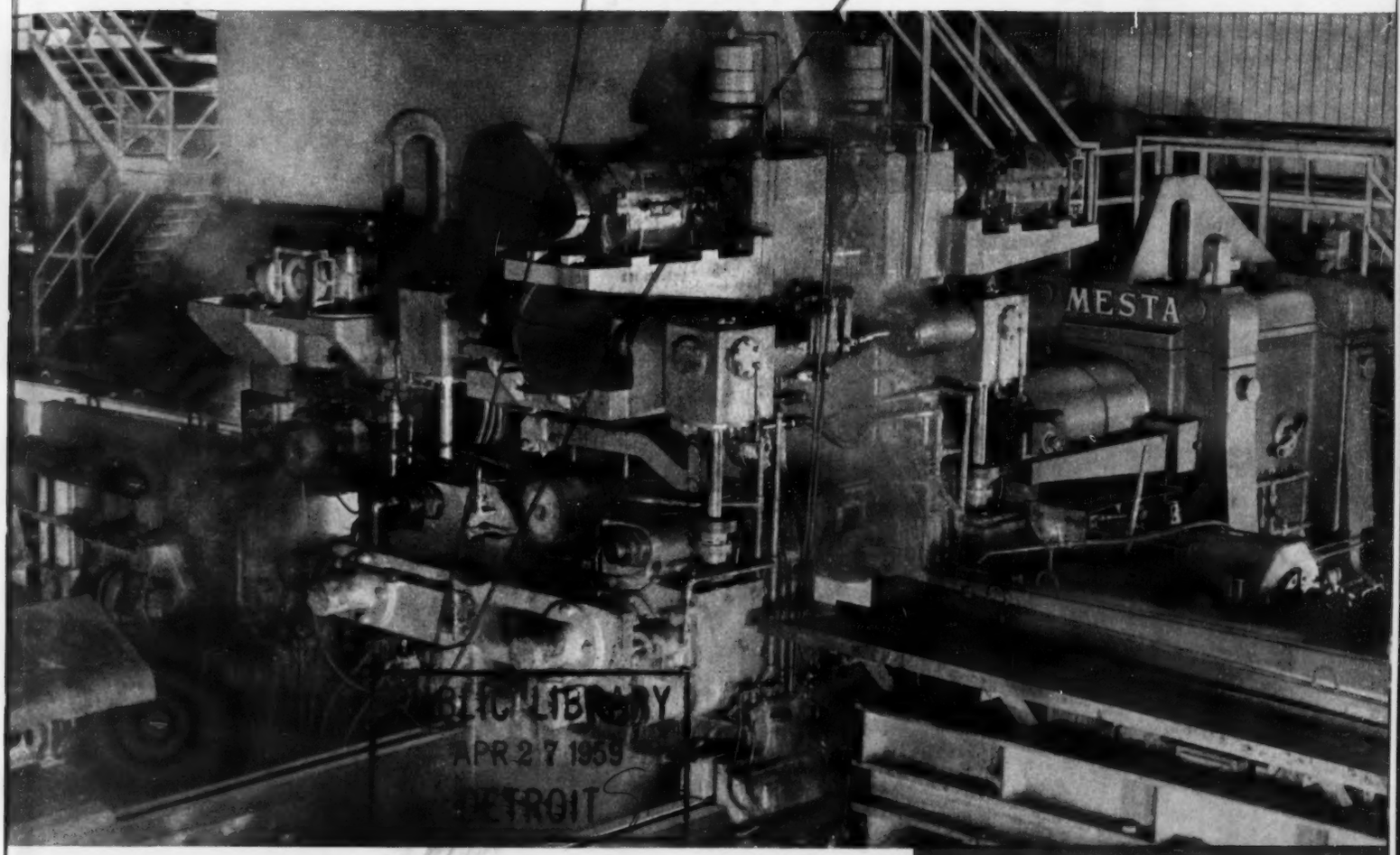
Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

TECHNOLOGY DEPARTMENT

APRIL, 1959



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DETROIT

Mesta Universal Structural Mill Rolling Wide Flange Beams on the 44" Universal Stand and the 34" Edging Stand at Inland Steel Company, Indiana Harbor Works

WIDE FLANGE BEAM AND STRUCTURAL MILLS

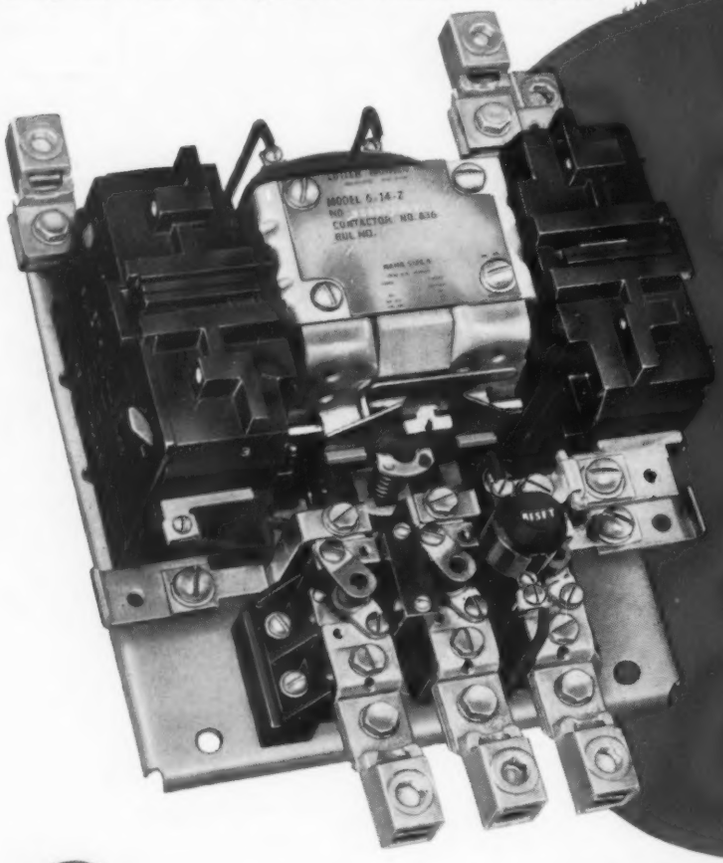
Designed and Built by MESTA

Designers and Builders of Complete Steel Plants

MESTA MACHINE COMPANY

PITTSBURGH, PENNSYLVANIA

50 Hp 220 Volts, 100 Hp 440/550 Volts Max. Polyphase



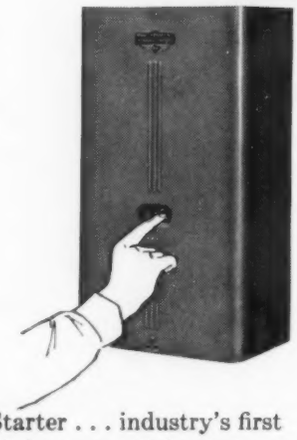
New SIZE 4 STARTER

...another Cutler-Hammer Three-Star achievement

New *compact design saves valuable panel area*

New *parallel contact design provides increased electrical life at full capacity*

New *low mass movable members insure superior mechanical life*



This is the new Cutler-Hammer NEMA Size 4 Starter . . . industry's first large horsepower starter offering all the desired features of the famous Cutler-Hammer Three-Star Motor Control line. Smaller, more compact, this new starter simplifies control panel design and saves valuable panel area. Tests of the new parallel contact structure show vastly improved electrical life even when operated at full capacity. Further, this new design reduces the size and weight of the movable members resulting in less impact wear and unsurpassed mechanical life. We've tested it against all others, why don't you? The new Cutler-Hammer Size 4 Starter ☆ installs easier, ☆ works better, ☆ and lasts far longer. Get all the facts today. Write for the new descriptive bulletin EN125-G-232, Cutler-Hammer Inc., Milwaukee 1, Wisconsin.

Look for these outstanding features . . . you'll find them only in Cutler-Hammer Three-Star Motor Control

- U-shaped cover easily removable for unobstructed inspection and accessibility
- Straight through wiring . . . line terminals at the top, load terminals at the bottom
- New pressure type terminals cut wiring time and effort
- Adjustable overload relays can be set to trip within 3% of full load motor current
- Precision cast overload sensing coils can't lose their accuracy
- Widely desired three-phase, three-coil overload protection is a standard optional feature . . . no special attachments or enclosures
- Indestructible molded magnet coil . . . color coded for positive voltage and frequency identification
- Easily installed convertible electrical interlocks require no special adapters . . . provide up to four extra control circuits
- Available as non-reversing, reversing, and multi-speed contactors and starters in the open type, NEMA 1, and all special purpose enclosures.

CUTLER-HAMMER CONTROL C-H

CUTLER-HAMMER

Cutler-Hammer Inc., Milwaukee, Wis. • *Division:* **Airborne Instruments Laboratory.** • *Subsidiary:* **Cutler-Hammer International, C. A.**

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IRON AND STEEL ENGINEER: published monthly by Association of Iron and Steel Engineers at 20th and Northampton Sts., Easton, Pa. Editorial and advertising offices, 1010 Empire Bldg., Pittsburgh 22, Pa. Second-class mail privileges authorized at Easton, Pa. This publication is authorized to be mailed at the special rates of postage prescribed by Section 132.122.

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at High Speeds Need Rugged Equipment

Higher and higher speeds and lighter and lighter gauges in tin plate put a greater and greater demand on equipment. High-speed Continuous Processing Lines must be more rugged than ever before to stand up to 21-turn operation. Our experience with processing lines dates back to the earliest production of strip in coils. In those years and today, ruggedness of equipment has been a trademark of Aetna-Standard.

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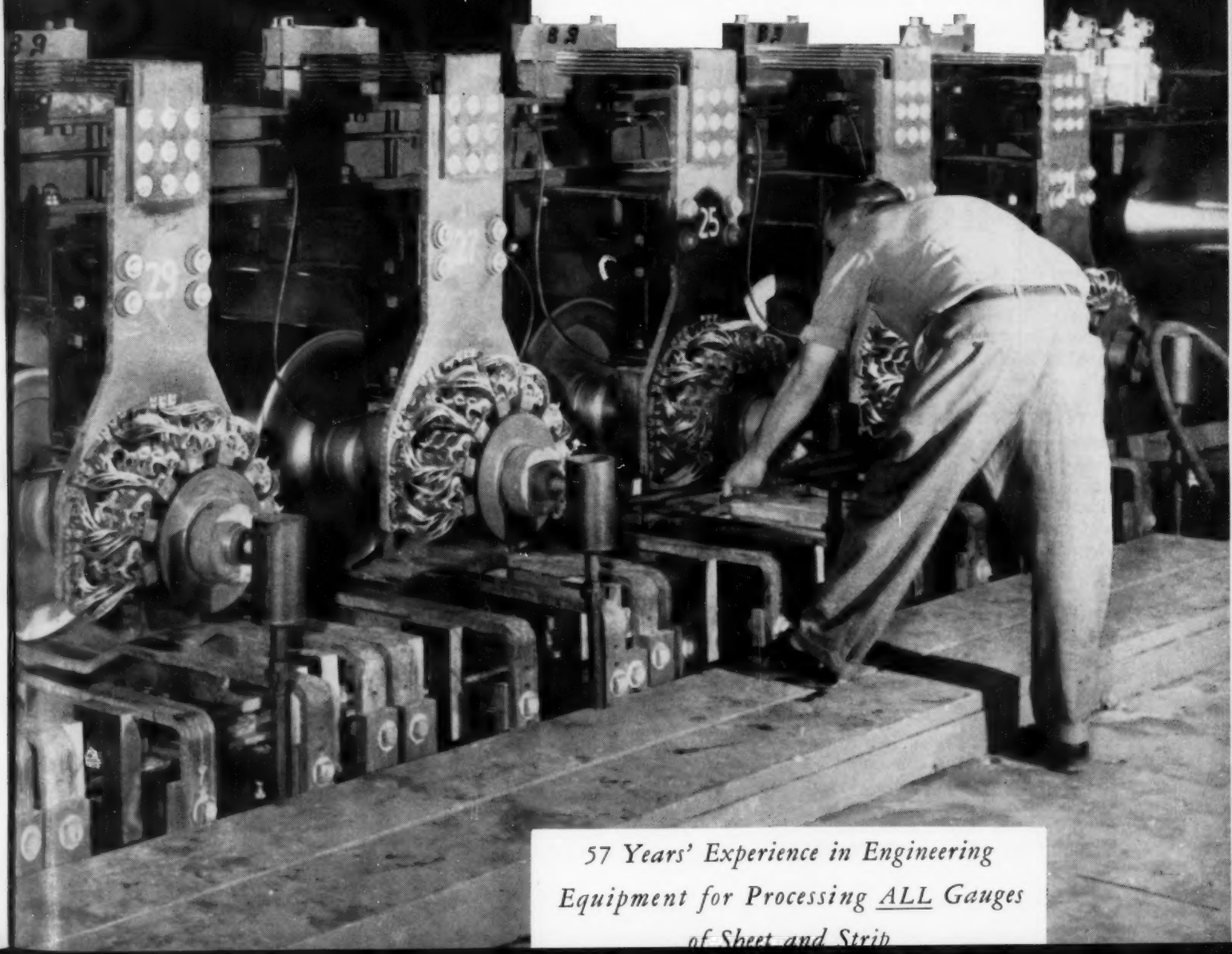
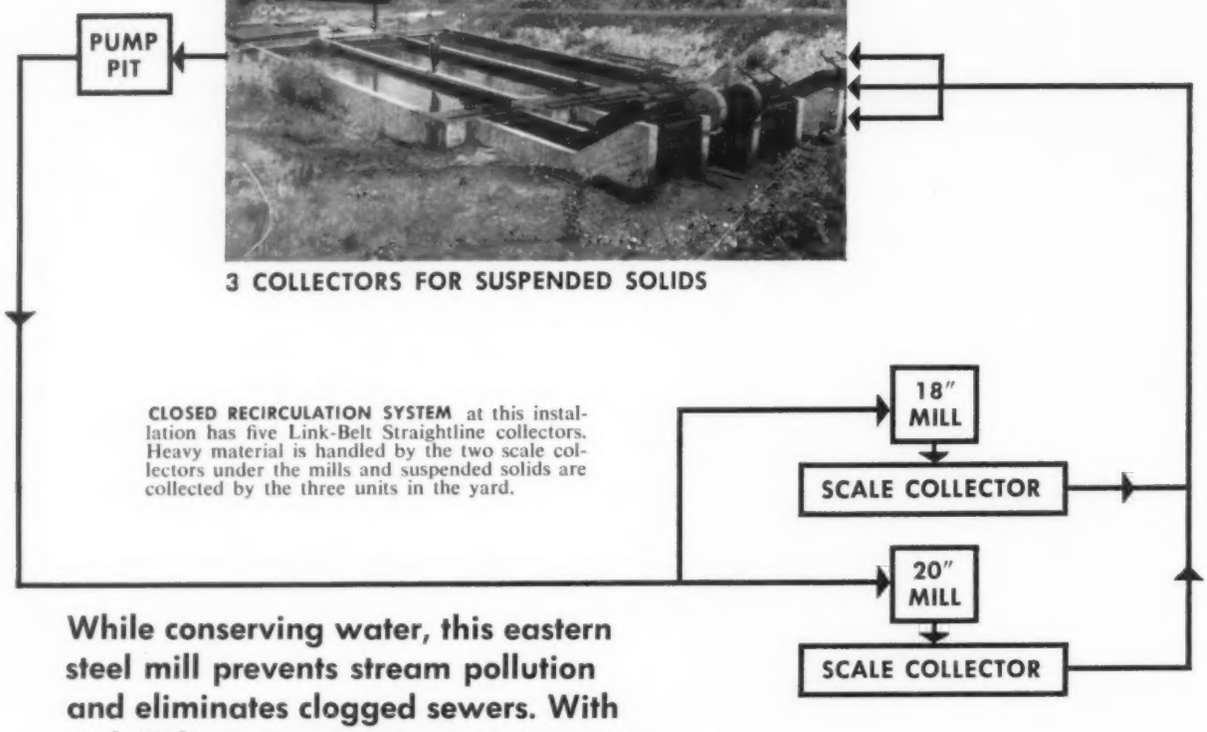


57 Years' Experience in Engineering Equipment for Processing ALL Gauges of Sheet and Strip

3 COLLECTORS FOR SUSPENDED SOLIDS



CLOSED RECIRCULATION SYSTEM at this installation has five Link-Belt Straightline collectors. Heavy material is handled by the two scale collectors under the mills and suspended solids are collected by the three units in the yard.

While conserving water, this eastern steel mill prevents stream pollution and eliminates clogged sewers. With Link-Belt waste treatment equipment . . .

process water makes the rounds . . . again and again and again

This steel mill demonstrates one of industry's most effective water conservation methods. In the Link-Belt equipped recirculation system, process water is cleared of solids . . . and sent back to work.

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Plants throughout the country are following suit. Some have reduced process water requirements to a fraction of the national average of 65,000 gallons per ton of steel . . . and realized substantial savings in the bargain.

Problems Vary

In most cases, recirculation involves more than mere pumping facilities. Making waste water suitable for re-use may demand removal of solids or neutralization of the liquid. Often by-products can be salvaged profitably. For example, mill scale is often recovered. These and other considerations take experience to analyze . . . a broad line of equipment to satisfy.

Link-Belt has both the experience and the equipment . . . developed during more than 35 years in sanitary engineering (not only industrial waste but large municipal sewage treatment plants as well). Whether your needs involve reduction of pollution, recirculation or the recovery of usable by-products—you can be sure of a system tailored to your conditions.

A Complete Line

Besides industrial waste equipment, Link-Belt also manufactures a complete line of conveying and power transmission equipment for steel mill service. We ask for the opportunity to work with your own engineers, chemists and consultants. Your nearest Link-Belt office will give you complete details.

LINK-BELT RIVETLESS CHAIN is used on all collectors at this steel mill. Drop-forged steel construction has strength and stamina needed for rugged abrasive duty.

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Published Monthly by

ASSOCIATION OF IRON AND STEEL ENGINEERS
1010 EMPIRE BUILDING PITTSBURGH 22, PENNSYLVANIA

Statements and opinions given in articles and papers appearing in "Iron and Steel Engineer" are the expressions of contributors, for which the Association of Iron and Steel Engineers assumes no responsibility.

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Indexed by Engineering Index and by Industrial Arts Index.

Single Copy Foreign Prepaid $2.00 (U. S. funds) Single Copy $1.50
Subscription price in U. S. and Canada (U. S. funds)..... $ 7.50 per year
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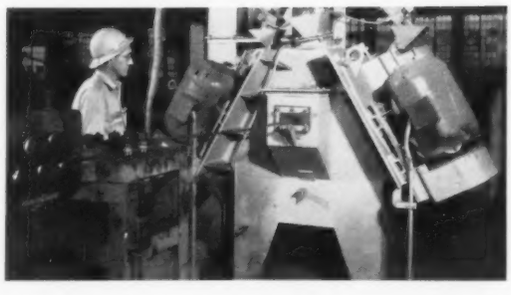
These cost-cutting Wheelabrator advantages are already being obtained by prominent producers of wire products in descaling various size rod at speeds up to 600 f.p.m. New applications in the wire products field are constantly being developed. It will pay you to investigate the Wheelabrator for your cleaning problems. Write today for complete information.



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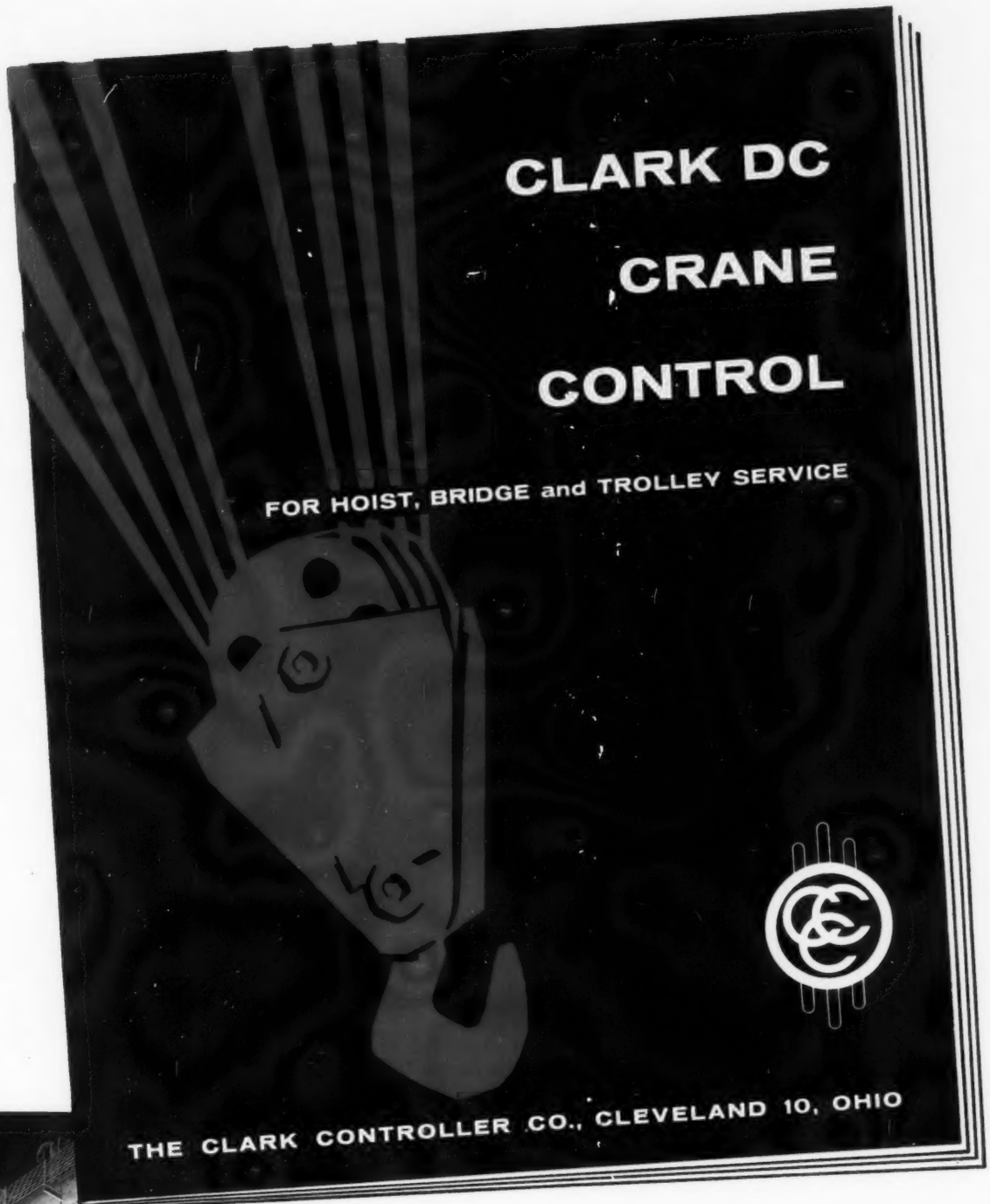

Clark has engineered and built control systems for all sizes and types of DC cranes, covering all five NEMA I.C1-42.01 Service Classifications. The hot ladle crane illustrated is an example of Group V, Steel Mill and Heavy Industrial.

Interested in DC Cranes?

This 20 page book outlines the basic principles of DC crane control, and provides the essential technical information you should have to select the controls best suited to your particular DC crane requirements. Profusely illustrated with photographs, charts and diagrams, the book explains in detail the circuits and components required for safe, dependable crane operation. As a major supplier of DC control of all types for over 30 years, The Clark Controller Company has pioneered and developed many of the advancements in modern DC crane control. This book provides an authoritative report of these developments.

Write today for your copy of this informative book. Ask for Bulletin 9100.

The **CLARK CONTROLLER** *Company* 11G

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Throughout the world Salem-Brosius has expanded and diversified its service capacity to industry to an unusual degree. The company figures prominently in the engineering and erection of industrial furnaces, heavy industrial equipment and materials handling facilities.

It is a leading producer of various fabricated components of atomic reactors and aircraft engine test facilities, offers a wide line of water purifying, softening and purity testing equipment and has just introduced a system for treating and recovering waste cleaning and pickling acids.

Its line of stainless and alloy fabricated and machined parts is well known throughout the food, chemical and atomic energy industries, as is its ability to produce close tolerance machined assemblies and parts, such as stamping and forming dies for the automobile, aircraft, glass, electronic and other industries, plastic injection molding dies and dies for die castings.

Now, with expanded engineering and erection facilities, Salem-Brosius offers a complete plant engineering service. This service includes engineering and erection . . . a complete turnkey job . . . for plants, production lines or processing facilities for the steel, non-ferrous, glass and other heavy product industries.

If you are contemplating new plant capacity, expanded production facilities or revamped plant layout, it will pay you to inquire of Salem-Brosius.

A pusher-type furnace for heating stainless and alloy steel slabs for rolling. This is typical of the major industrial furnaces for which Salem-Brosius is well known.

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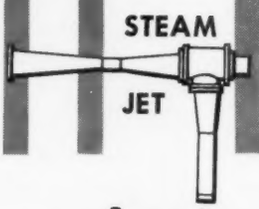
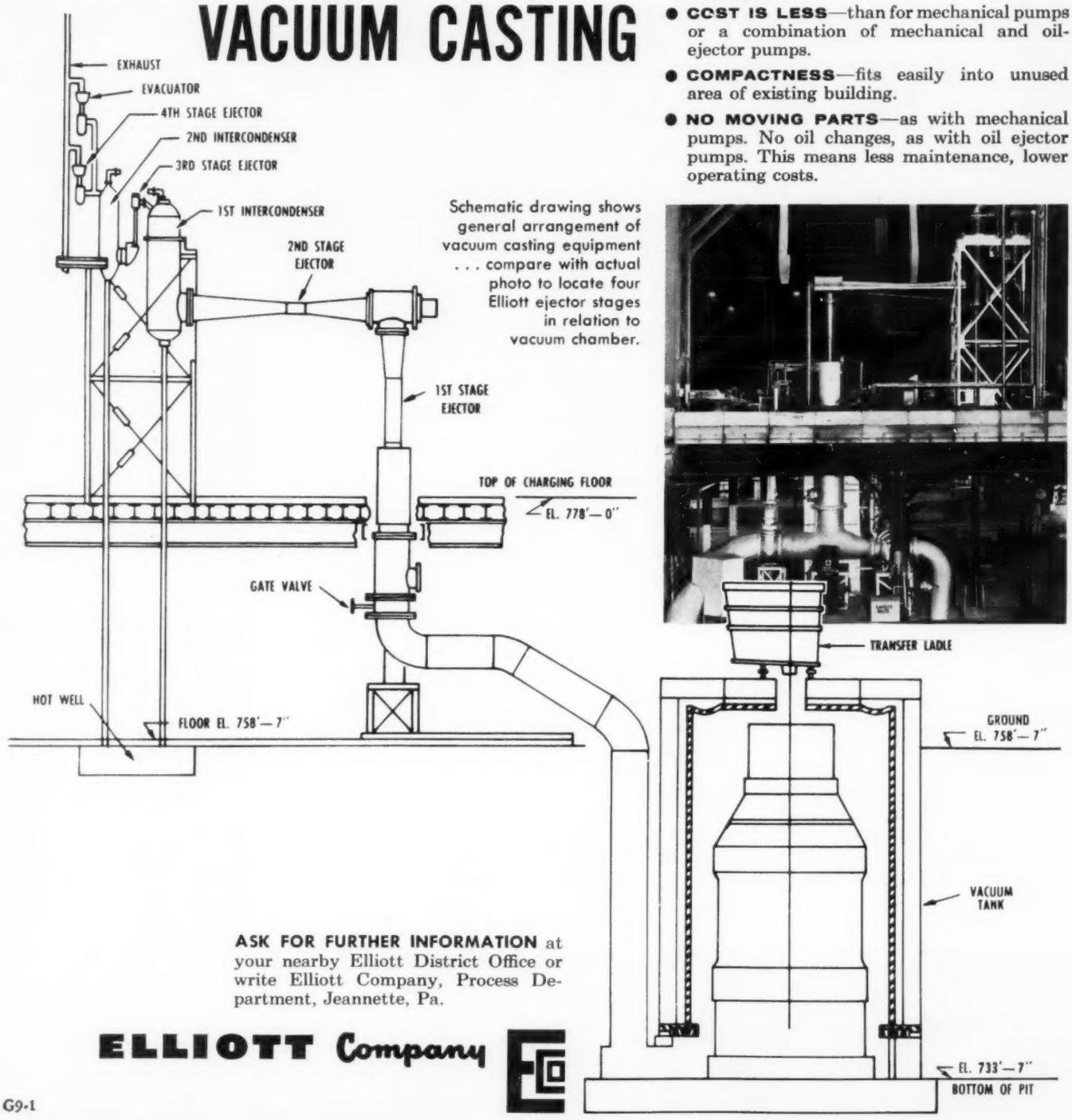
ELLIOTT EJECTORS



selected by United States Steel for VACUUM CASTING

This simplified method of removing unwanted gases assures stronger, more uniform forgings and reduced flaking and embrittlement. One of the several production-size degassing operations served by Elliott steam-jet ejectors is the United States Steel Corporation installation seen here. A 36-in. four-stage ejector system, it was selected because:

- **COST IS LESS**—than for mechanical pumps or a combination of mechanical and oil-ejector pumps.
- **COMPACTNESS**—fits easily into unused area of existing building.
- **NO MOVING PARTS**—as with mechanical pumps. No oil changes, as with oil ejector pumps. This means less maintenance, lower operating costs.



Schematic drawing shows general arrangement of vacuum casting equipment . . . compare with actual photo to locate four Elliott ejector stages in relation to vacuum chamber.

ASK FOR FURTHER INFORMATION at your nearby Elliott District Office or write Elliott Company, Process Department, Jeannette, Pa.

ELLIOTT Company

G9-1

These incomparable annealing results prove

LEE WILSON'S OPENED COIL METHOD BEST!

Those familiar with annealing will recognize the chart below as an outstanding example of controlled uniformity in annealing.

This large 13-ton coil was subjected to 90 tests after it had been annealed in just 7¾ hours. From inside to outside Rockwell variance was held to an amazingly low three points.

This is not the exception, but rather the rule when steel is annealed by the new Opened Coil method developed and perfected by Lee Wilson engineers. Two pilot plants—one for tinplate and one for carbon steels—are now under construction—will soon be placed in operation in two of America's leading steel plants.

TABLE 1

SUMMARY PHYSICAL TESTS, METALLURGICAL TEST

SIZE: .0359" x 42¾" x 76¾"

PART: EXTERIOR DOOR PANEL

Weight 26,900 — Al-Killed Steel

		Outside as Annealed				Center			Inside as Annealed				
		1	2	3	4	5	6	7	8	9	10	Average	Range
ROCKWELL HARDNESS	E_1	43	44	43	44	44	43	43	43	44	44	43.5	43/44
	C	44	42	42	43	44	43	43	44	44	43	43.2	42/44
	E_2	43	42	44	44	44	42	42	44	45	44	43.4	42/45
OLSEN DUCTILITY	E_1	415	415	420	420	420	420	420	415	415	415	417.5	415/420
	C	410	415	415	425	420	420	415	420	415	415	417.0	410/425
	E_2	410	415	420	425	415	415	415	415	415	420	416.5	410/425
MICRO GRAIN SIZE	E_1	6	6/7	6/7	6/7	7	7	7/8	7/8	7	7/8	.....	.....
	C	6/7	6/7	6/7	6/7	7/8	7/8	7/8	7/8	7/8	7/8	.....	.....
	E_2	6/7	6/7	6	6/7	7/8	7/8	7	7	7	7		

		L	T	L	T	L	T
TENSILE RESULTS	Yld. Str. (psi)	27,540	27,780	26,460	27,010	26,750	27,780
	Tens. Str. (psi)	44,910	45,290	45,760	45,210	46,680	47,050
	% Elong. (2")	40.0	39.0	40.0	38.0	39.0	39.0

Opened coil being rewound into a tight coil after annealing by Lee Wilson's patented coil handling system.

Lee Wilson® ENGINEERING COMPANY, INC.

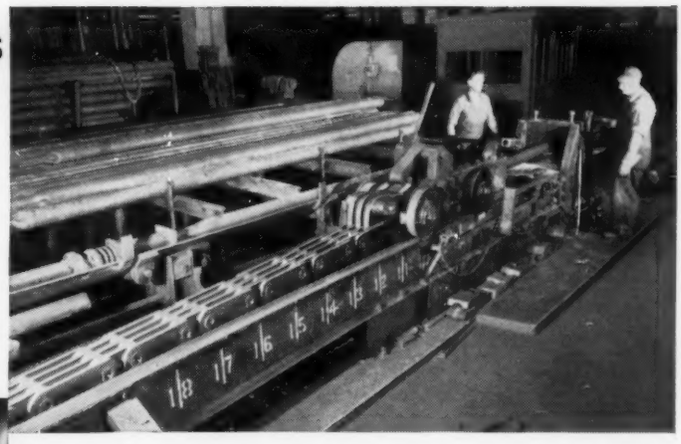
7800 CAMP ROAD • CLEVELAND 14, OHIO

HIGH PRODUCTION ANNEALING SYSTEMS

MAKE THE BEST METALS BETTER

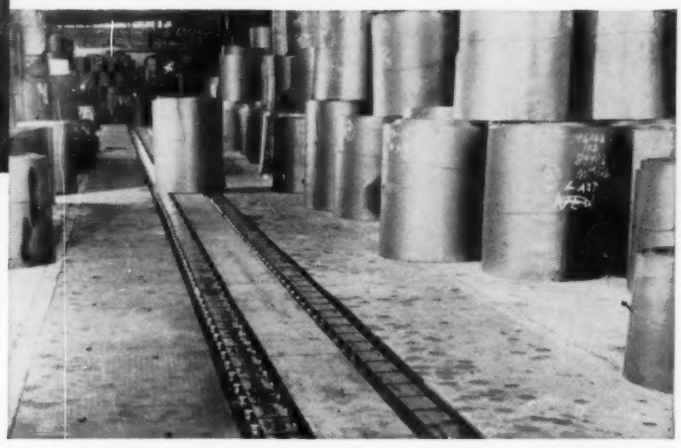
® ORIGINATORS AND LEADING PRODUCERS OF OPENED COIL AND SINGLE STACK FURNACES

The PLUS values of REX® CHAINS



DRAW IT...

...COOL IT



CARRY IT...

more dependably with REX

DRAW IT... For the dependable ruggedness and strength required to transmit the tremendous, steady pull to draw seamless steel tubing, your *plus value* choice is Rex Steel Draw-Bench Chain, made of carefully heat-treated steels for durability. Available in a variety of sizes and steels to suit any application.

COOL IT... To assure the timed, uniform cooling of hot steel tubes, Rex Chabelco Steel Cooling Rock Chain and Attachments provide dependable *plus value* service. Matched chain strands, accurate control of chain pitch, precision-made parts, carefully controlled heat-treatment add up to smooth tube handling ...long service life.

CARRY IT... Rex Steel Coil Conveyor Chain has built-in dependability to assure long life, freedom from breakdowns in this vital service. Special heavy-duty, anti-friction roller chain supplies the smooth-traveling ride for coiled strip or sheet. Rugged platforms mounted on chain attachments provide steady, level carrying surface.

DEPENDABLE SERVICE and chains, too, for coiled wire conveyors, catching and feeding tables, continuous sheet conveyors and annealing ovens, and power transmission equipment. If you're looking for more dependable *plus value* equipment in these operations, why not write CHAIN Belt Company, 4693 W. Greenfield Ave., Milwaukee 1, Wis. In Canada, write CHAIN Belt (Canada) Ltd., 1181 Sheppard Ave. East, Toronto.

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Crops *and* Shorts

Δ Weeks ahead of the scheduled opening, it appears that negotiations between the Steelworkers and their industry are already under way in the public press. Union president David J. McDonald has been blasting off with all the tact and logic of a rhinoceros. From what we read in the papers, he is approaching the negotiations with "a deep sense" of responsibility not only to his own members but to the nation at large. He insists that the industry wants a strike and will force one on the steelworkers. All he is trying to do is get an "extra billion dollars" a year for almost every type of business, which he is sure can come without a price increase. After all, that's only about $10 a ton and profits also run about $10 a ton after federal income taxes.

If Mr. McDonald were closer to the steel plants he'd know that gas producers are obsolete today. The important fuel is oil.

Δ Unfortunately, President Eisenhower issued a plea to stop inflation in which he mentioned price increases but omitted any specific verbal reference to wages. Mr. McDonald quickly seized this omission as an indication that the President puts the onus of price increases on industry. Mr. Eisenhower should know by now that such pronouncements must be spelled out in kindergarten simplicity.

Δ How true the Wall Street Journal:

> At social functions, it appears
> She makes the biggest hit
> Who's poured into her dress and then
> Runs over just a bit.

Δ Some figures recently quoted in the Reader's Digest show that the recipient of a $4000 income in 1939 had $3910 left after paying federal income tax. In 1957, the same income was actually worth only $1658 because income tax had increased by $530 and inflation had taken $1722. Putting it another way, to match a 1939 income of $4000, you needed an income of $10,097 in 1957—and the way things are going now, an income of $24,415 will be needed in 1975, only 16 years away. It's not a pleasant prospect for the 50-year-olds who will be retiring about that time, and it's much worse for present retirees who might still be living then.

It is small wonder that price controls are gaining converts. Congressional bills now under consideration would have the government pass judgment on proposed price increases. Ignoring such judgments would doubtless lead to controls with teeth in them. It all stems from mounting concern over inflation. There is just one thing—any such controls must include the real basic factor in price structure, wages.

Δ As someone recently observed, by the time a family acquires a nest egg, inflation has turned it into chicken feed.

Δ And speaking of congressional bills and spending money, HR 2165 calls for the creation of a national grammar commission with paid staff to "establish simplified rules of grammar and rules for simplified phonetic or other spelling of words in the English language." The commission shall prepare and edit the "United States Official Dictionary." Incidentally, the commission "may include in the dictionary any new word which it coins and finds to be an improvement of the language."

Then we'll have English, American and Official.

Δ A current dodge used by some taxing bodies to avoid the blame for mushrooming taxes is the appointment of an irreproachable committee of business men, industrialists and union leaders to survey the situation and suggest new or increased taxes.

We'd like to see the same approach used on the local, state and federal budgets with the idea of reducing expenditures. Better yet is the suggestion to put a designer of women's bathing suits in charge of government budgets.

Δ The house organ Powercrax made a patriotic offer to Uncle Sam (too late now): "If you'll waive our paying the amount due you April 15 in income tax, we'll do what we can on behalf of the nation and its economy in helping to end the recession by rushing right out and spending this amount."

Δ Metal can production in the United States for 1958 totaled 41,500,000,000 cans. This is second only to 1956, when production totaled 41,800,000,000.

Δ In a recent column in the Scripps-Howard newspapers, Inez Robb complained about erratic and uncertain service on airlines. She said that a lot of travelers would go back to railraods if air service isn't improved.

We agree heartily with her complaints, but Mrs. Robb hasn't looked at rail schedules lately. Actually, we were ahead of her, but we found train schedules so reduced in the past two or three years that it's well nigh impossible to do serious traveling by rail. This is the result of competition by private automobiles and partially subsidized buses and planes, and of the railroads' own desire to get out of passenger service.

In any case, it's a serious situation. We can't expect railroads to run idle trains. Nor can we expect them to stand by with a full head of steam just waiting for weather to close in or for a national emergency to come up. But we can't do without trains.

Δ The nation's retail stores had a record high of $200,300,000,000 in sales in 1958. It was a peculiar recession.

Johns-Manville Insulating Fire

put physical and thermal properties *in proper balance!*

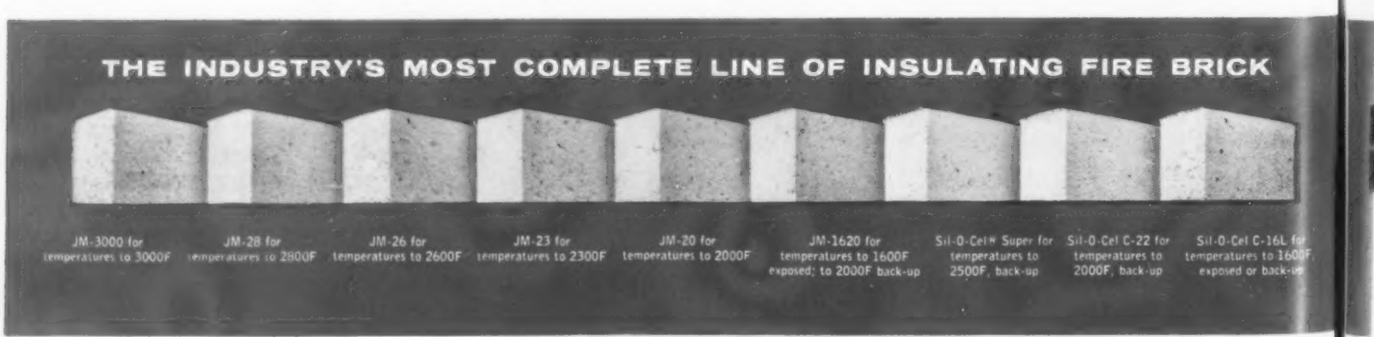
...provide essential high-temperature resistance and low conductivity...yet maintain high load-bearing strength with low spalling!

Only Johns-Manville's insulating fire brick family offers the right combination of properties to meet the diversified requirements of modern furnace construction.

Johns-Manville's nine different insulating fire brick mean you never have to settle for a brick that's nearly right! Instead you choose the one insulating fire brick or combination of brick that best meets your specific requirements for temperature resistance, load-bearing strength, conductivity and density.

Johns-Manville has two strategically located plants for the production of insulating fire brick: Lompoc, California and Zelienople, Pennsylvania. Insulating fire brick and other Refractory Products are available from the stocks of Authorized J-M distributors in key industrial areas.

For further information, call your nearest J-M representative. Or write for brochure IN-115A to Johns-Manville, Box 14, New York 16, N.Y. In Canada, Port Credit, Ontario.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JM-20 for temperatures to 2000F
JM-1620 for temperatures to 1600F exposed; to 2000F back-up
Sil-O-Cel™ Super for temperatures to 2500F, back-up
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JOHNS-MANVILLE JM PRODUCTS

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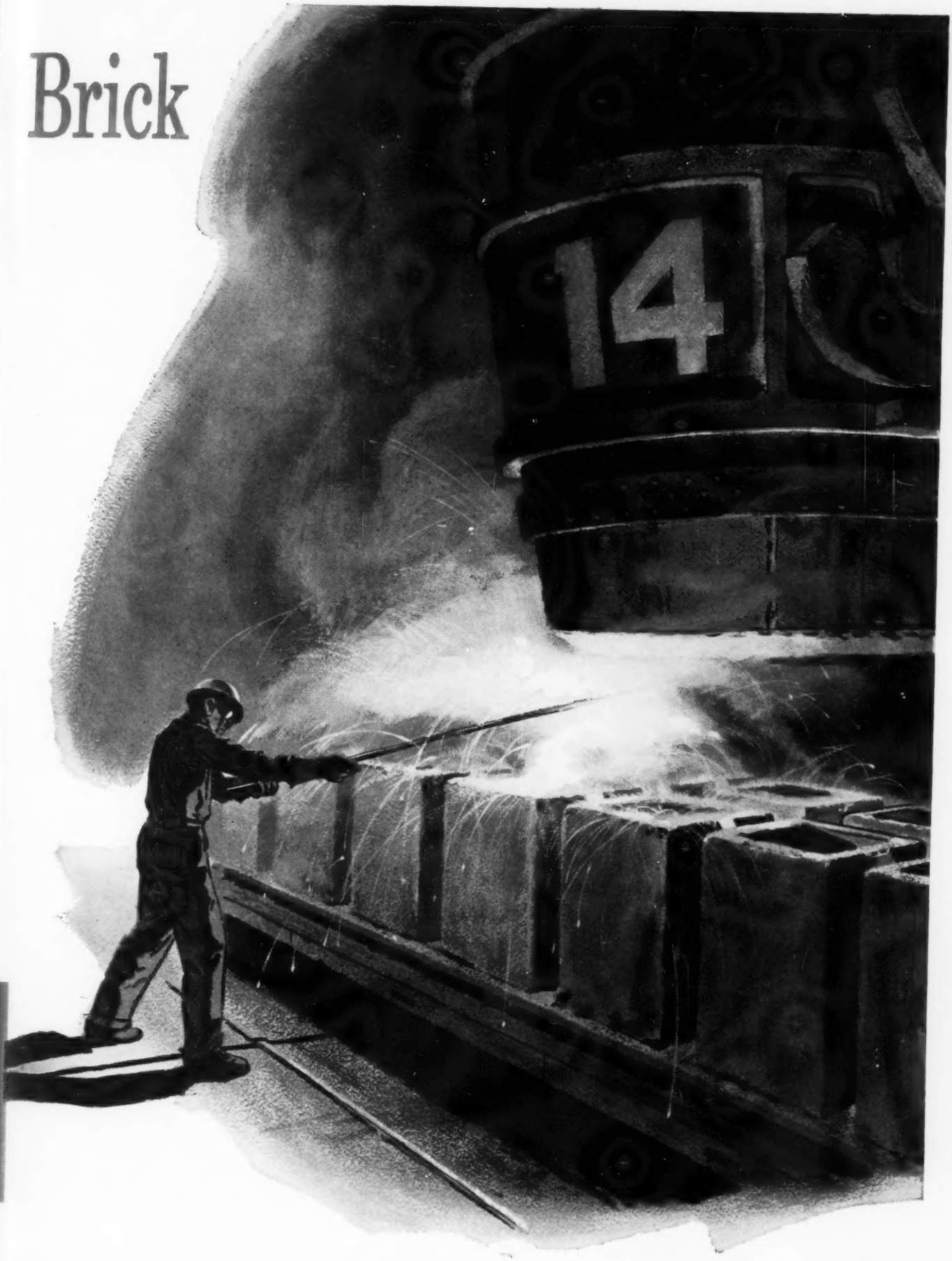

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3 GREAT NEW Motoblox®

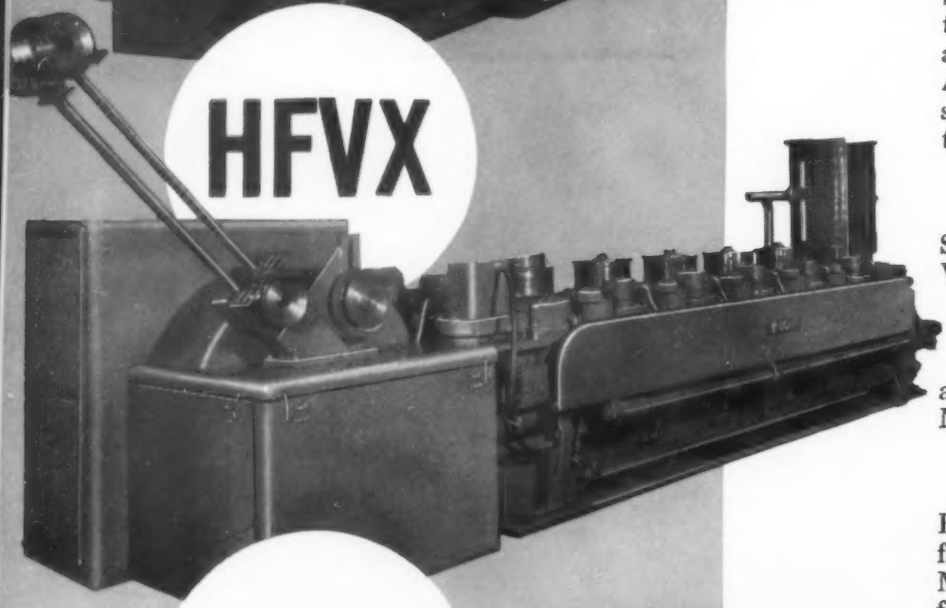
engineered for today's demands

by Vaughn®

HRK

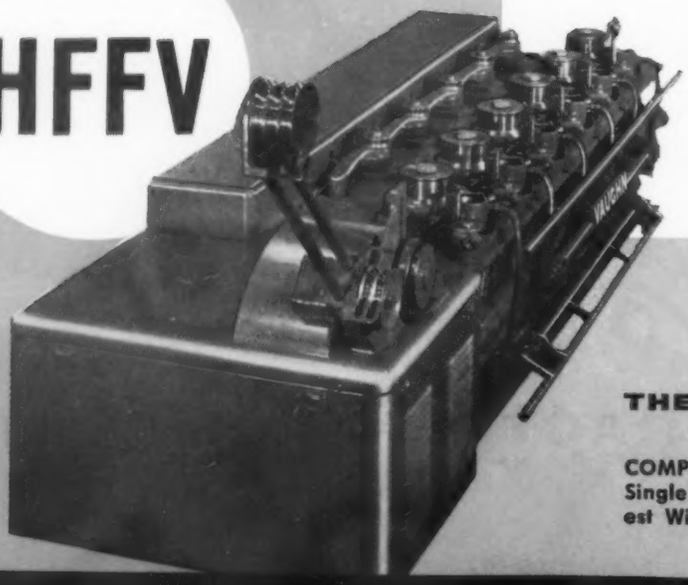
Exceptionally effective cooling on the Vaughn HRK Motoblox is provided by water circulating in the interior of the 27″ diameter intermediate blocks, augmented by an external blast of air. Ample wire storage is assured by offsetting the individual block units on this "straight-through" rod machine.

HFVX



Superseding a previous model, the Vaughn HFVX Motoblox is the ideal machine for drawing the smaller sizes of alloy and high carbon steels. Speed, cooling, flexibility, and safety are effectively combined in this modern Motoblox.

HFFV



For those still finer sizes that are preferably drawn *dry*, the Vaughn HFFV Motoblox is the answer! Sizes ranging from .025″ diameter and finer may be finished on this 8″ diameter block version of the Motoblox, with or without spooler.

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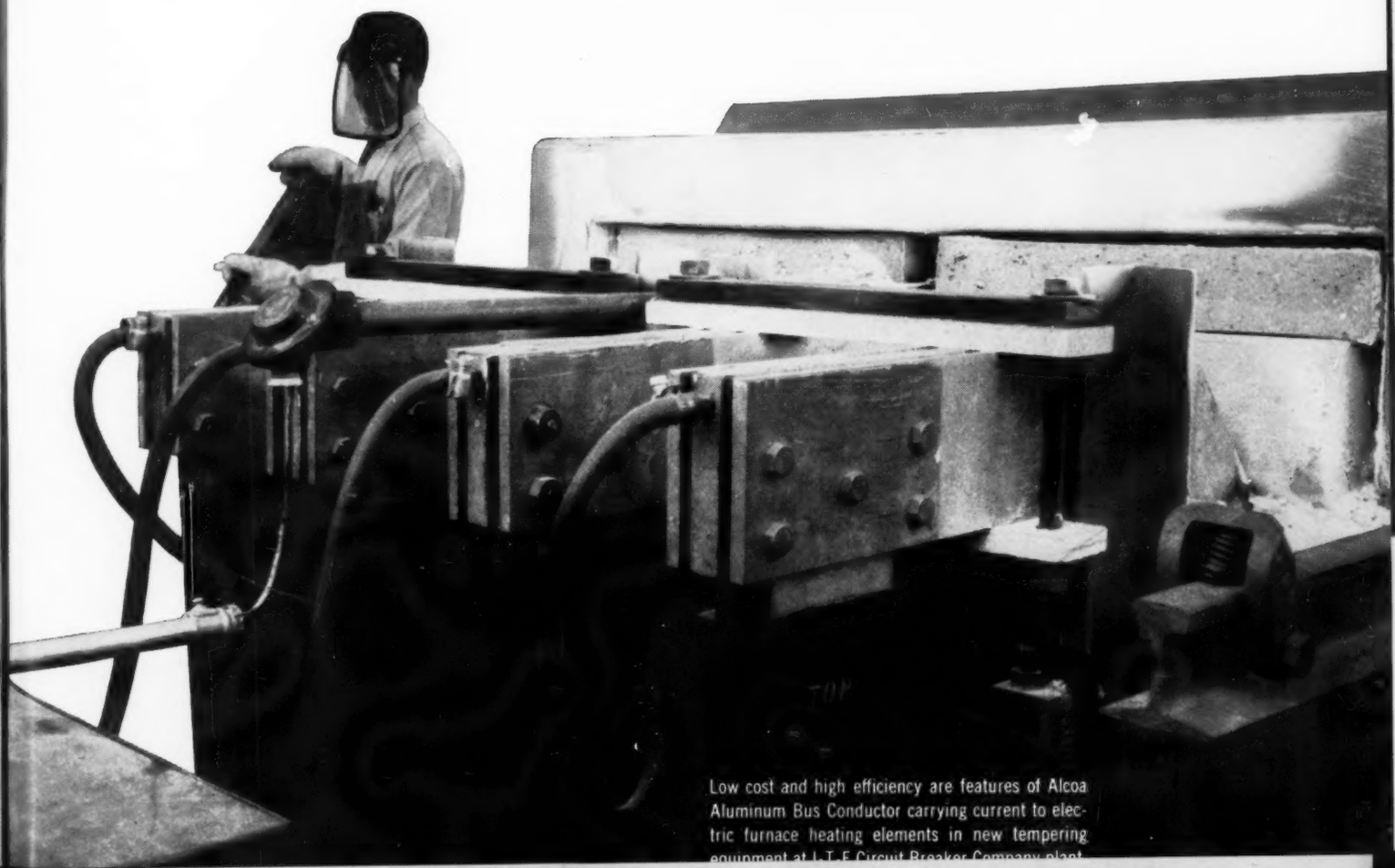

Low cost and high efficiency are features of Alcoa Aluminum Bus Conductor carrying current to electric furnace heating elements in new tempering equipment at I-T-E Circuit Breaker Company plant

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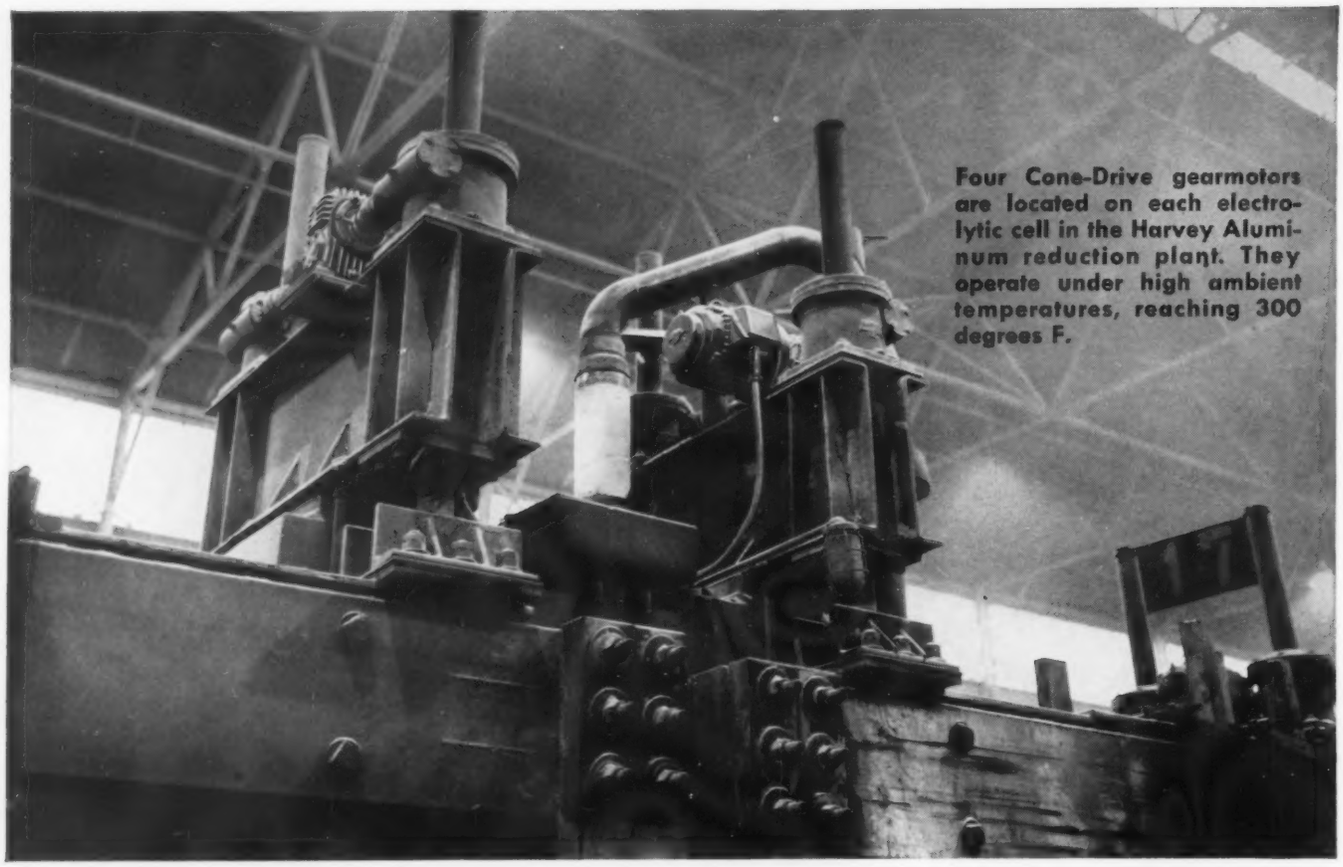
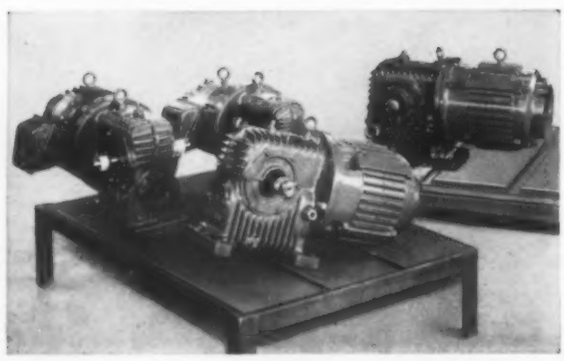


Four Cone-Drive gearmotors are located on each electrolytic cell in the Harvey Aluminum reduction plant. They operate under high ambient temperatures, reaching 300 degrees F.

AT HARVEY ALUMINUM . . .
100,000,000-lb yearly capacity using 1,000 Cone-Drive gearmotors



Four double-enveloping worm gearmotors used by Harvey Aluminum are shown here after test run in Cone-Drive plant. They were palletized in groups of four for shipment to Oregon smelter.

From its modern reduction plant at The Dalles, Oregon, Harvey ships primary aluminum in pig, ingot and billet forms all over America. The smelter includes the latest and most efficient equipment and operating techniques. Reflecting this modern equipment are 1,000 Cone-Drive double-enveloping worm gearmotors, used to control the height of anodes and casings in relation to the molten aluminum bath in each of the electric furnaces. Annual capacity is more than 100-million pounds.

The gearmotors are operated under high ambient temperatures that reach 300° F. This was an important consideration in Harvey's selection of Cone-Drive gearmotors. In addition, the ability to withstand the full force of stalled driving motors and constant reversing operations figured in Cone-Drive gearing's selection.

Cone-Drive double-enveloping worm gearmotors are available in a wide variety of styles and sizes. Models include standard shaft or hollow shaft with worm over or under or gearshaft vertical. Capacities range from ¼ to 40 HP and reductions from 3.3:1 to 240:1. Ask for Catalog No. 58 for complete specifications.

CONE-DRIVE GEARS DIVISION MICHIGAN TOOL COMPANY

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L-D PROCESS
BASIC OXYGEN PROCESS
OXYGEN STEELMAKING

Which is which—How do they differ?

In the rapidly broadening use of oxygen in steelmaking, various names have been applied to differing, and even the same, oxygen steel processes.

To clarify terminology, the American Iron and Steel Institute has assigned the description BASIC OXYGEN PROCESS as the generic term for any basic steelmaking process wherein oxygen gas above atmospheric concentration is a dominant factor. The American Iron and Steel Institute definition is "The term 'basic oxygen steel' is used to define a steel which is considered to be the equivalent of basic open-hearth steel, and whose residual nitrogen content is not in excess of 0.007 per cent."

Specification writing societies including the American Society for Testing Materials and the American Petroleum Institute have applied the same terminology. The American Bureau of Shipping has also used the same general terminology with certain added qualifications.

L-D Process Explained

The L-D PROCESS, for which Kaiser Engineers is the exclusive U.S. licensor, is one of these BASIC OXYGEN PROCESSES and the one in widest use today. Of approximately 70 furnaces operating or building within this classification, 62 are the L-D PROCESS type.

(The remaining 8 are rotating vessel processes which should not be confused with the L-D PROCESS.)

L-D PROCESS is the generally accepted designation of the process where molten pig iron and scrap is subjected to high purity oxygen blown vertically onto its surface in an upright furnace.

L-D PROCESS in action

Charging molten iron

Charging scrap

Blowing

Tapping

L-D Process Advantages

Reasons for world-wide preference of the L-D PROCESS include faster production, better product quality, adaptability to a variety of hot metal analyses, and the low capital investment of about $13 to $15 per annual ingot ton vs. $18 for electric furnaces and $33 for open-hearths.

The L-D PROCESS has also been termed "Linz-Donau" (Linz on the Danube), "Linz-Donawitz," location of the two originating steel plants in Austria and "Linzer Dusenverfahren" which has been interpreted as "Linz Jet Process." Actually, no special significance is attached today in the U. S. to the letters "L-D" other than the fact that they specifically identify, in every part of the world, the generally preferred process for adding new steelmaking facilities.

Complete Steel Plant by KE

Kaiser Engineers designs and builds complete L-D PROCESS installations; also designs and builds complete steel plants including blast furnaces, open-hearth and electric furnace installations, sinter plants, rolling mills, pipe mills, by-products plants, ore beneficiation, air pollution control and water treatment facilities.

For complete new-plant or expansion service, from process design to start-up day, KE offers experience coupled with traditional Kaiser ingenuity. The L-D PROCESS is an example of KE's capability in the application of new developments to the steel industry.

For full information on L-D PROCESS or other KE services in steel plant design and construction, call or write KE at:

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New York, 300 Park Ave., PL 9-1100
Oakland, 1924 Broadway, CR 1-2211

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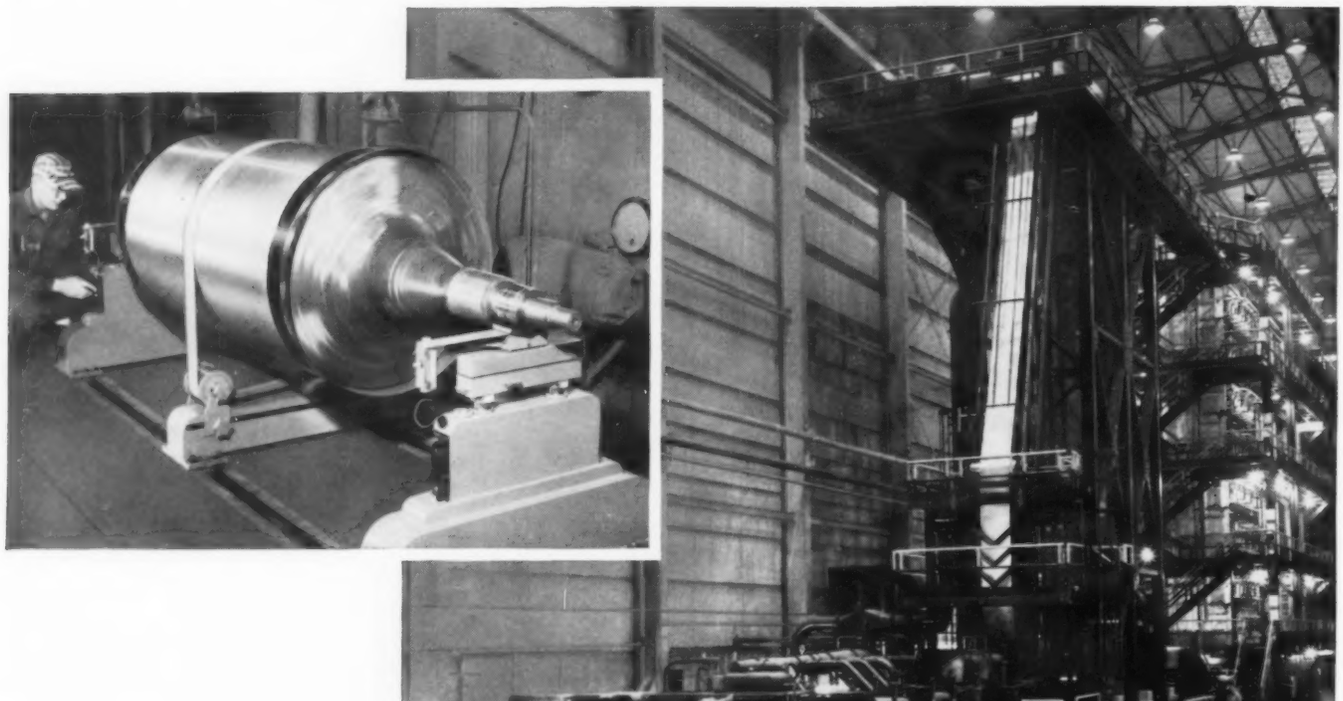

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Write Electro-Alloys Division, 1044 Taylor Street, Elyria, Ohio, for complete technical information.

AMERICAN Brake Shoe COMPANY

ELECTRO-ALLOYS DIVISION • Elyria, Ohio

patent reviews

By MELVIN NORD, Patent Attorney, Detroit, Mich.

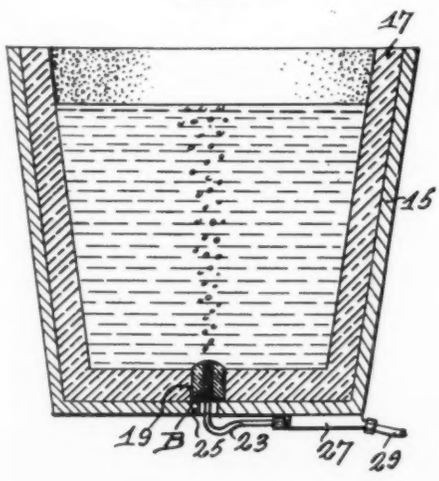
Copies of patents may be obtained from the Commissioner of Patents, Washington 25, D. C., at 25 cents . . . . patents reviewed cover period November 4, 1958 through November 25, 1958.

OXYGEN REFINING METHOD

△ U. S. 2,855,293, issued Oct. 7, 1958, to Guy Savard and Robert Lee, assigned to L'Air Liquide, Societe Anonyme pour l'Etude et l'Exploitation des Procedes Georges Claude, describes a method of refining iron with oxygen without the formation of red fumes.

In the present invention oxygen is injected into the metal through the shell and refractory lining of the containing vessel at a point below its surface. The oxygen gas is injected into the molten iron at a pressure of 400 to 1000 psi. The thermodynamic property of the expanding oxygen gas is employed to cool the injector tube 25, shown in Figure 1, thus helping to reduce its rate of erosion. The high velocity of the expanded oxygen gas through the tube also adds greatly to the cooling effect. These two factors make it possible to eliminate external cooling.

Figure 1



Nitrogen is blown in at the beginning to keep the injector holes open until all the metal has been poured into the vessel. Then the oxygen is turned on.

HOT TOP CONSTRUCTION

△ U. S. 2,858,588 issued Nov. 4, 1958, to William E. Hoffman, describes a hot top structure for use in the casting of ingots. The present invention eliminates the necessity for caulking the large regions which have heretofore been caulked and necessitates caulking only a very small region which can be done quickly and usually quite accurately without difficulty.

As shown in Figure 2 the hot top of the present invention provides slides 17 and 18 in the annular body of the hot top which are adapted to move outwardly and engage the side walls of the opening of the mold. Since the slides can be caused to move into intimate contact with the side walls of the mold opening, metal is unable to flow between the slide portions and the mold walls; and only small areas between the adjacent slides need be caulked.

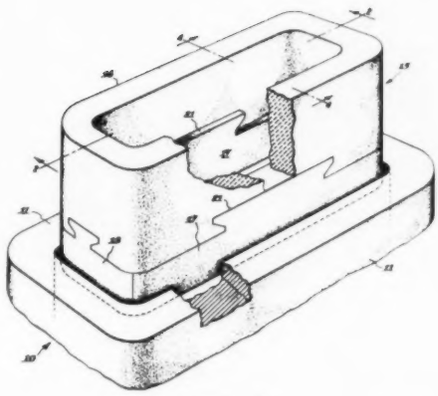


Figure 2

BLAST FURNACE SPRAY COOLING APPARATUS

△ U. S. 2,859,030, issued Nov. 4, 1958, to Ernest B. Snyder, provides a blast furnace construction having an unconfined water spray cooling means below the hearth bottom for cooling the hearth.

As shown in Figure 3 the entire under surface of the hearth is subjected to a fine spray of an unconfined cooling fluid such as water from the orifices in pipes 18 and 19. This is an efficient means for maintaining the bottom of the hearth at a desired lower temperature so as to increase its life to lengthen the operating period between repairs and to materially lessen the danger of

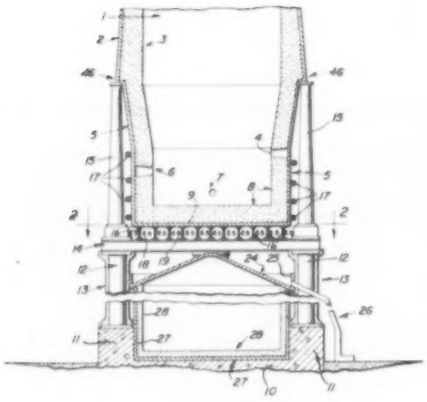


Figure 3

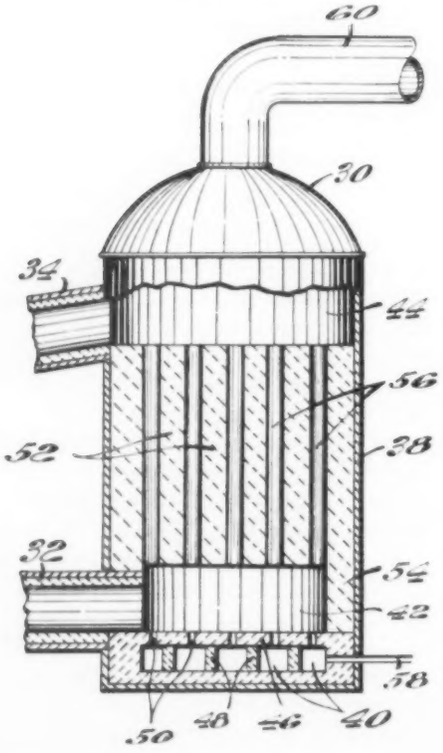
molten metal breaking through the bottom of the hearth.

REMOVAL OF SULPHUR FROM IRON

△ U. S. 2,859,106, issued Nov. 4, 1958, to Randolph Antonsen, describes a process and apparatus for removing sulphur from molten iron and recovering the sulphur.

It has been found that a large proportion of the sulphur content of iron can be easily removed and recovered as a valuable by-product by continuously treating a portion of the slag while in the furnace and in contact with the surface of the molten iron to remove the available sulphur. This is accomplished by blowing an oxygen-containing gas through it thereby reducing the sulphur content of the main slag body. The sulphur combined with the oxygen as oxides of sulphur is then removed, separated, and recovered in accordance with known methods.

Figure 4



As shown in Figure 4 the slag treater 30 consists of a metal shell 38 within which are a gas chamber 40, a bottom treating chamber 42 and a top chamber 44. Refractory floor 46, supported on piers 48, separates the gas and treating chambers 40 and 42, respectively, and contains orifices 50. Between chambers 42 and 44 is a refractory mass 52 supported on ring pier 54 through which pass flues 56 that are vertically alined with orifices 50. A gas supply conduit 58 connects into gas chamber 40, and a flue 60 is provided at the top of the treater.

When sufficient molten iron and slag have accumulated so that slag flows into conduit 32, oxygen, preferably preheated, is introduced into gas chamber 40 through conduit 58 to flow upward through orifices 50, through the slag in chamber 42, and through flues 56. As soon as enough slag has accumulated in the treating chamber 42, it is lifted by the gas stream through flues 56 into upper chamber 44. The slag thus lifted by the gas streams into the upper chamber flows back into the blast furnace through conduit 34. During its flow through the treater, the slag is in contact with the oxygen in the lifting gas for a time sufficient to enable a substantial proportion of the sulphur in the slag to combine with the oxygen to form oxides of sulphur which percolate through and separate from the slag in the upper chamber and are withdrawn from treater 30 through gas flue 60.

TREATMENT OF GALVANIZED IRON TO INHIBIT CORROSION

△ U. S. 2,859,146, issued Nov. 4, 1958, to Alvin F. Prust, assigned to Republic Steel Corp., describes a method of treating galvanized iron to inhibit the staining and discoloration which results from the formation of the zinc corrosion product.

It has been discovered that treating freshly galvanized surfaces with a bath consisting of a dilute solution of borax, phosphoric acid and sodium nitrite followed by wiping of the aqueous liquid from the surface and drying of the surface results in remarkable protection against the development of wet storage stain or white rust. The treated sheets or other articles are highly resistant to the occurrence of this particular type of corrosion and retain their metallic luster, essentially undiminished, over long periods even under adverse conditions of moisture or wetness. Furthermore, the treatment does not result in any yellowish or other significant coloration of the galvanized surface, and the appearance is therefore highly satisfactory from the standpoint of a variety of uses. The coating or modification of the surface that results from the treatment is not found to interfere with painting or other treatments or operations which may be applied to galvanized products.

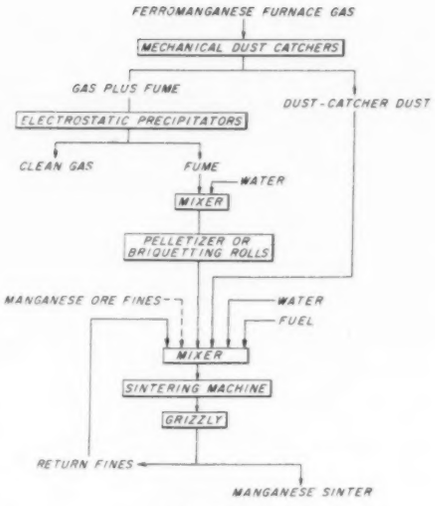


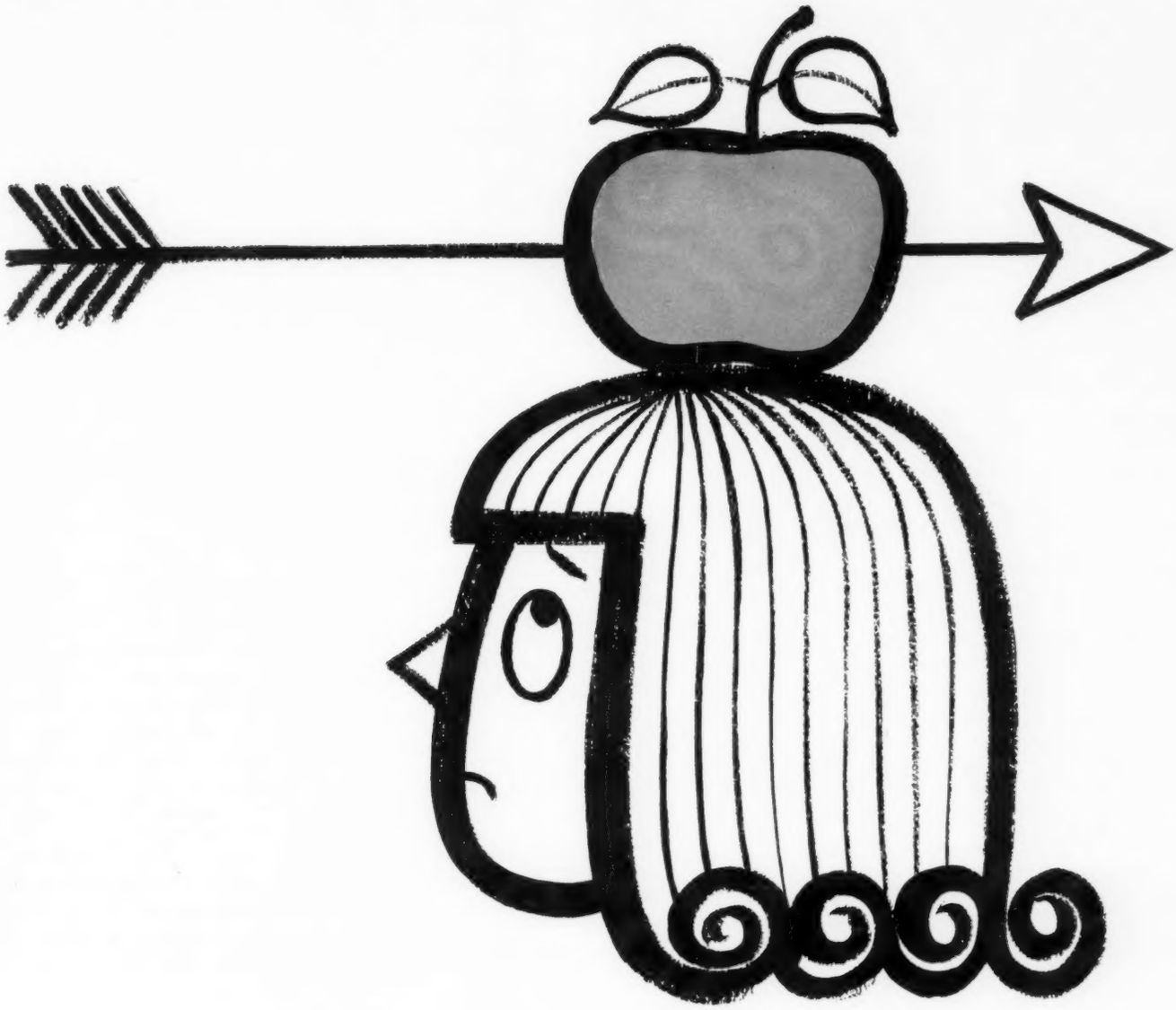
Figure 5

Figure 5 shows the process in the form of a flow sheet.

MINING OF TACONITE ORES

△ U. S. 2,859,952, issued Nov. 11, 1958, to Harry La Tour and Howard D. Wren, assigned to Armco Steel Corp., describes a method of mining, fracturing and beneficiating taconite ores using high frequency magnetic energy. The principle utilized is that of causing a disturbance to change the dimensions of one portion of the rock relative to another portion by such an amount that the fracture strain in tension of the material in the restraining region is exceeded. It has been found that taconite ore can be fractured by subjecting the rock to high frequency energy, i.e., energy on the order of 25 kw at a frequency of about 4 to 7,000,000 cycles per sec.

In Figure 6 a stratum of iron bearing ore is shown at 30. The overbur-



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OTHER PATENTS OF INTEREST TO THE IRON AND STEEL ENGINEER

Patent No.	Date	Subject	Inventor or assignee
2,858,589	11/4/58	Ductile iron castings	Morris Bean & Co.
2,859,023	11/4/58	Continuous furnaces	Robert Bucci
2,859,107	11/4/58	Recovery of vanadium from iron ores	Hoganas-Billesholms Aktiebolag
2,859,323	11/4/58	Differential temperature measurement on billets	Magnethermic Corp.
2,859,957	11/11/58	Sintering apparatus	Ole Rolfsen et al.
2,860,044	11/11/58	Production of iron powder of desired grain size	Hoganas-Billesholms Aktiebolag
2,860,046	11/11/58	Exothermic reduction of oxide ores	John O. Edstrom et al.
2,860,704	11/18/58	Automatic shear for cutting strip	United States Steel Corp.
2,860,764	11/18/58	Bloom manipulator	United States Steel Corp.
2,860,791	11/18/58	Cupola charging apparatus	Modern Equipment Co.
2,861,028	11/18/58	Production of coke from caking coal	Adolf Jenkner
2,861,305	11/25/58	Ingot casting	The British Iron & Steel Research Association
2,861,332	11/25/58	Method of tensioning guys	United States Steel Corp.
2,861,609	11/25/58	Production of nonaging silicon killed steel	United States Steel Corp.
2,861,879	11/25/58	Production of iron from steel scrap	Easton Metal Powder Co., Inc.
2,861,883	11/25/58	Precipitation hardenable, corrosion resistant, chromium-nickel stainless steel alloy	Cooper Alloy Corp.
2,861,908	11/25/58	Manufacture of a steel alloy casting	American Steel Foundries

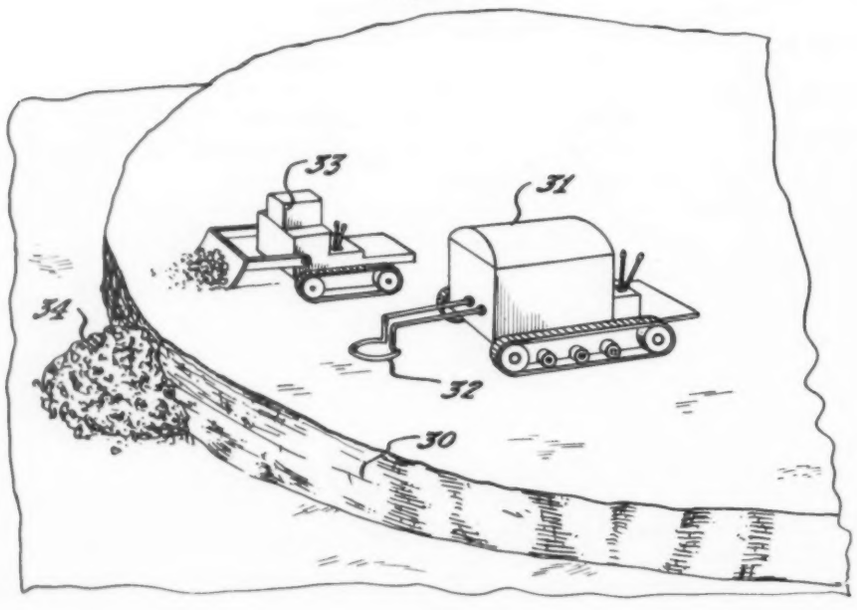
den has been removed to expose a stratum of ore. At 31 is a tractor which is provided with a high frequency generating unit and a pancake type of coil 32. The coil 32 is so arranged that as the prime mover 31 moves over the stratum the coil 32 passes in close proximity over the exposed surface of the ore. During this travel high frequency energy is generated and the ore is continuously or intermittently subjected to tensile stresses beyond the fracture strain of the ore. Thereafter a bulldozer, as indicated at 33, can simply scrape the fractured ore layer away to expose another untreated layer. If the operation is at the side of a cliff or hill the bulldozer 33 may simply push the fractured layer over the edge of the hill so that it will be further fractured and comminuted in the fall as indicated by the pile 34.

METHOD OF FRITTING FERROMANGANESE FLUE DUST

△ U. S. 2,861,881, issued Nov. 25, 1958, to Donald D. Phelps, assigned to United States Steel Corp., describes a method of fritting or agglomerating ferromanganese flue dust.

As shown in Figure 7 gas from a ferromanganese blast furnace passes first through mechanical dust catchers and then through an electrostatic precipitator. The precipitator dust or fume is moistened, mixed and agglomerated, e.g., pelletized or briquetted. Dust catcher dust, agglomerated precipitator dust, return fines from the subsequent fritting machine, fuel and optionally manganese ore fines are moistened and mixed to form a feed. This feed is introduced to a sintering machine or equivalent fritting means and fritted. If desired, the feed can be reagglomerated before fritting, this second agglomerating step being necessary for fritting by means other than sintering. The feed has sufficient permeability to produce a strong fritted product without excessive losses. The fritted product is screened over a grizzly or the like, and the undersize is returned to the feed mixer. The oversize constitutes a finished fritted product suitable for charging to a ferromanganese blast furnace.

Figure 6



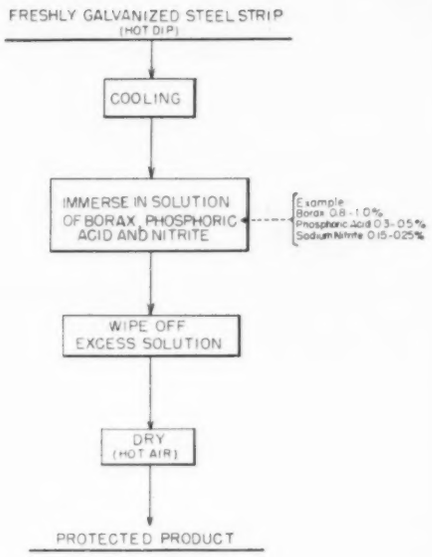


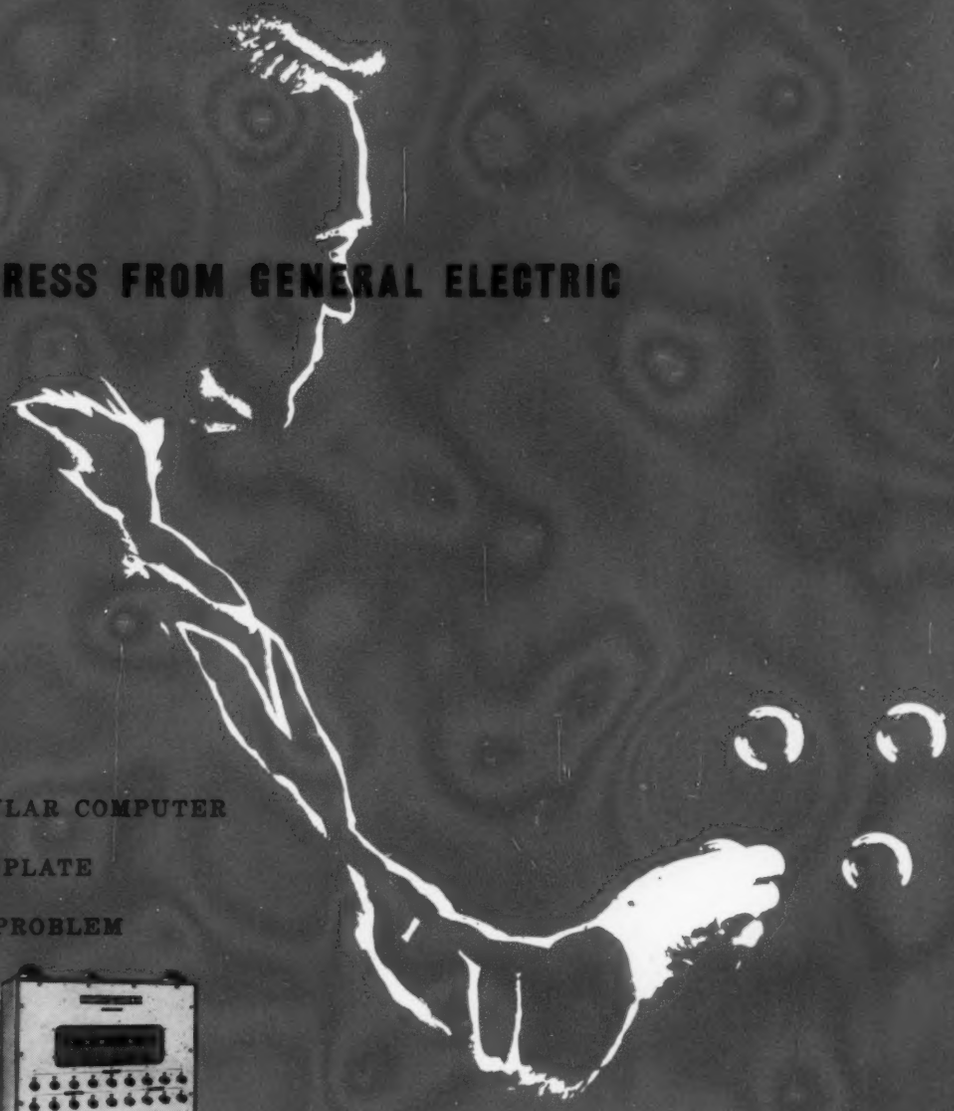
Figure 7

COLD ROLLING OF STEEL

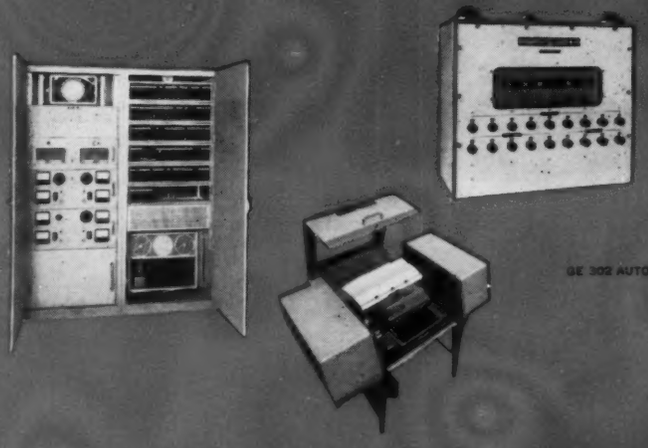
△ U. S. 2,859,145, issued Nov. 4, 1958, to Richard I. Somers and Paul L. Petry, assigned to Parker Rust Proof Co. and Acme-Newport Steel Co., describes a process which permits the elimination of the conventional oiling step prior to rolling, and produces a smoother, flatter rolled strip than normally obtainable.

The process includes the continuous coating of steel strip with a phosphate coating of sufficient uniformity in thickness to facilitate cold rolling. The uniformity of this coating enables the holding of gage during continuous cold rolling.

COMPUTER PROGRESS FROM GENERAL ELECTRIC



CUSTOM DESIGNING MODULAR COMPUTER COMPONENTS TO SOLVE A TINPLATE INSPECTION AND BILLING PROBLEM



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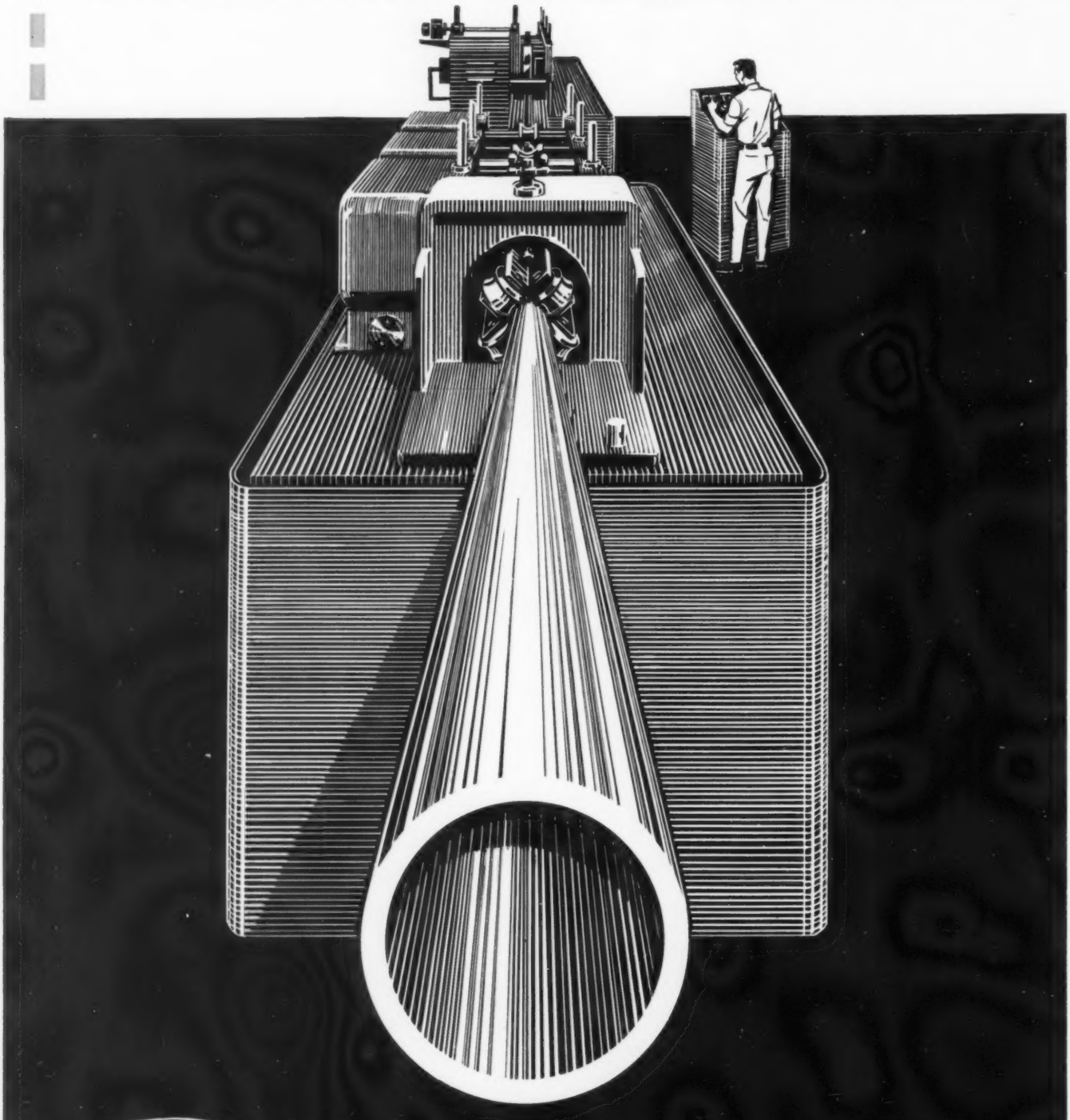

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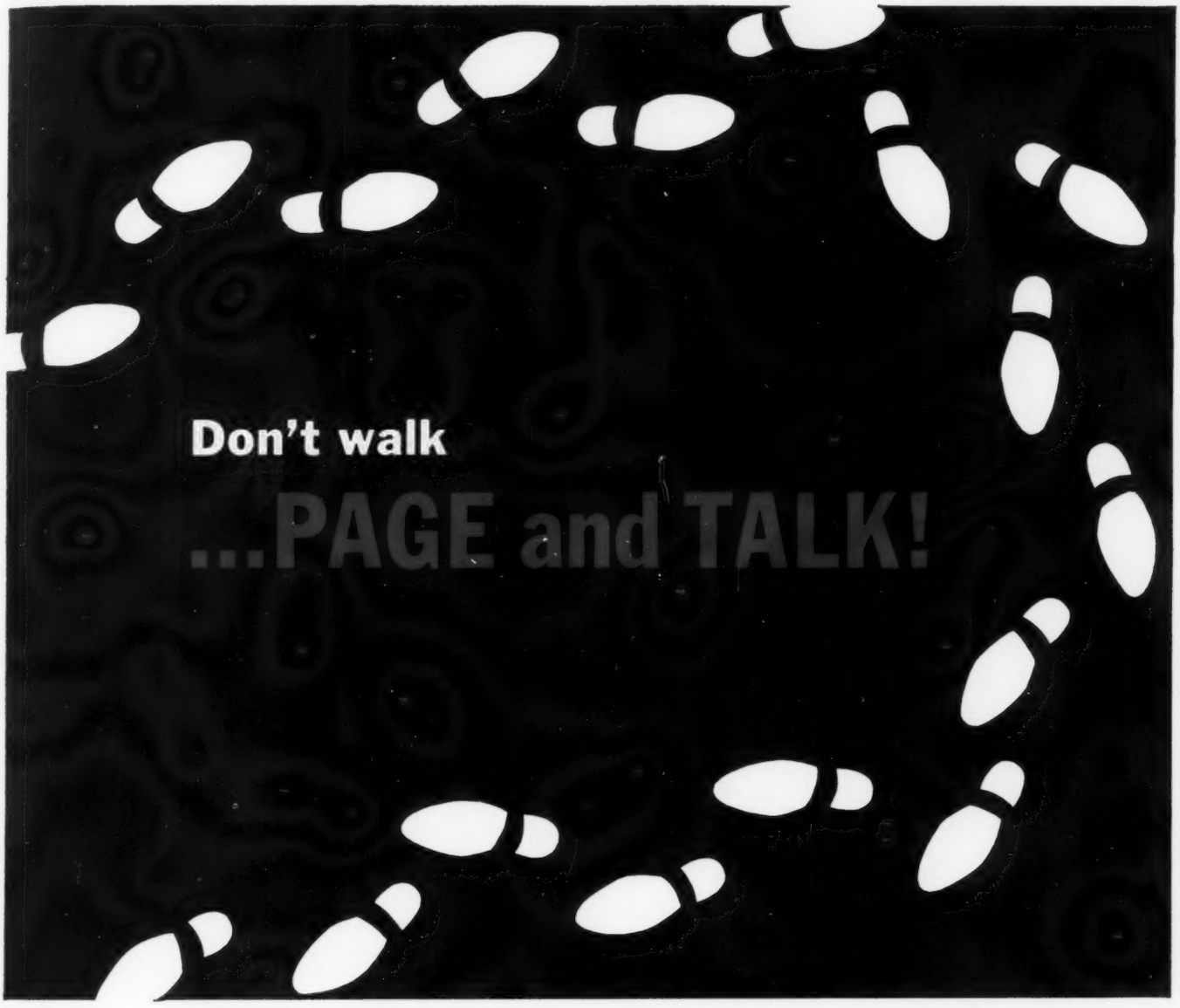

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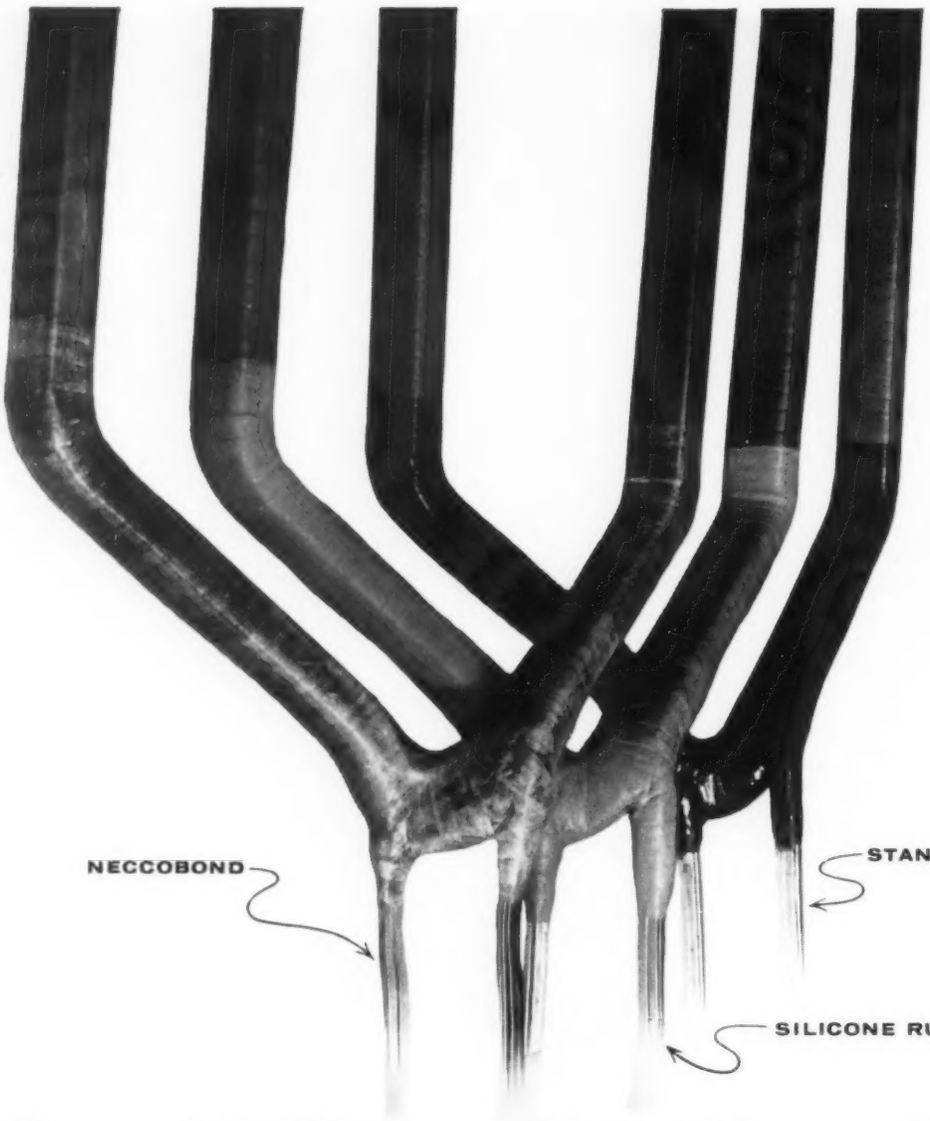

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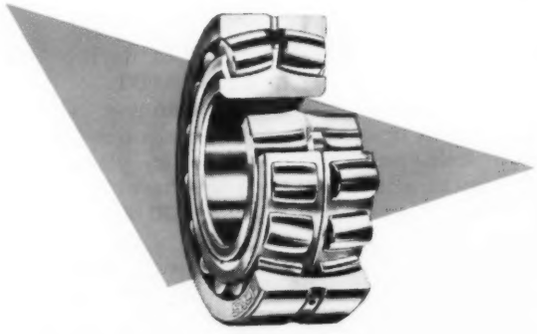

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Using their new standard of cleanness, Dowell cleaned the line of hydrocarbon residues, carbon black, grease, mill scale, and rust. Meanwhile, plant crews made mechanical alterations to the line at a cost of about $25,000. Dowell's charge was $20,000; the job was done in 3½ days.

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Chemical cleaning service for all industry DOWELL

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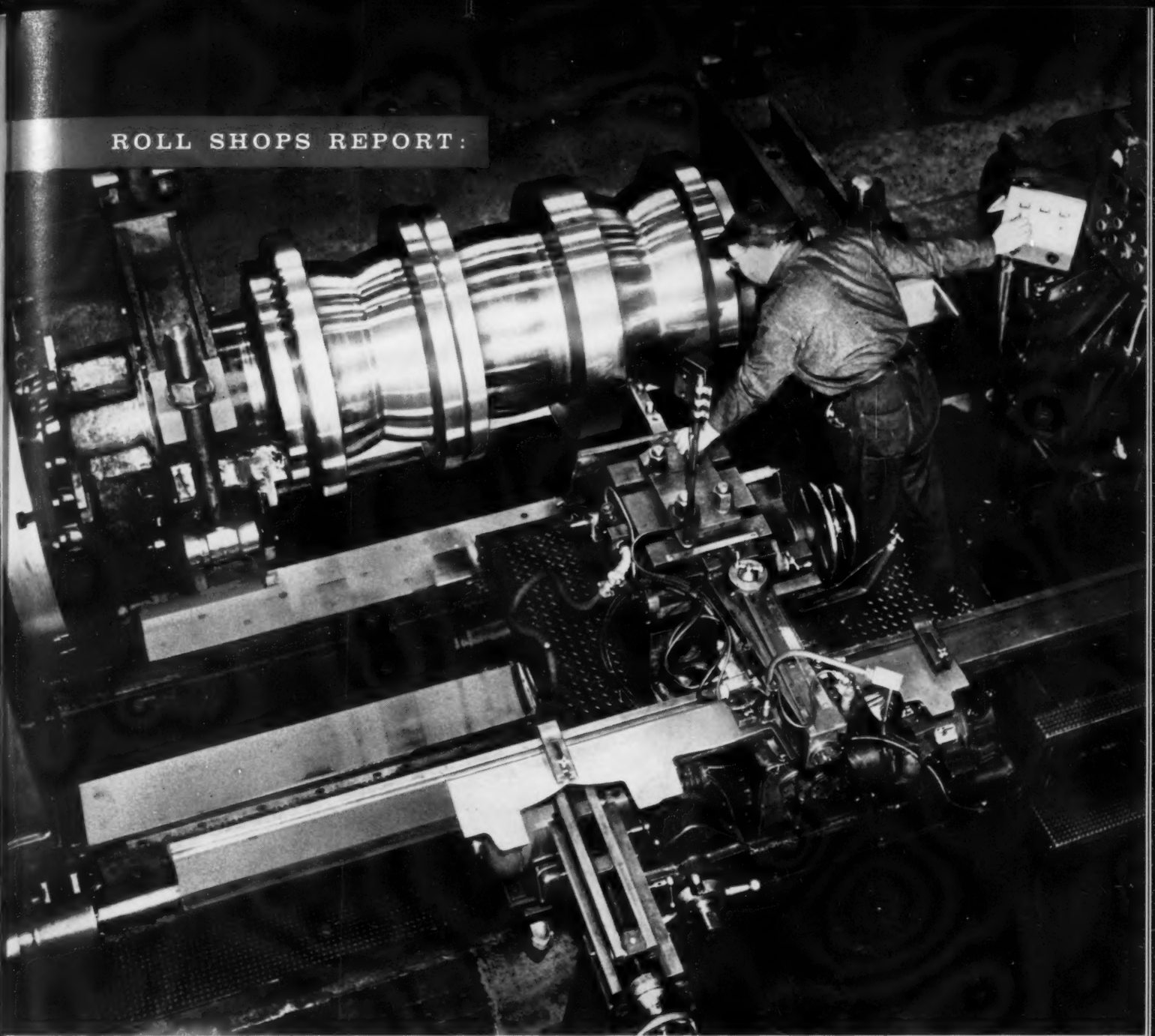

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What are your most urgent roll problems? A growing work load...high roll turning costs . . . a shrinking supply of skilled roll turners? *If that's the case, you're no different from 90 per cent of steel mill roll shops.*

Mack-Hemp Automatic Contouring lathes solve these problems for you. They reduce turning time by taking off more metal in one hour than a roll turner can in three or four on a block lathe. Yet Mack-Hemp lathes accurately reproduce within 0.001-inch complicated roll patterns from ful-size templates by means of an electronic "pilot."

That's why many leading steel mill roll shops are using Mack-Hemp contouring lathes and why a number of others have ordered them.

To find out how these lathes can help you, drop us a line today.

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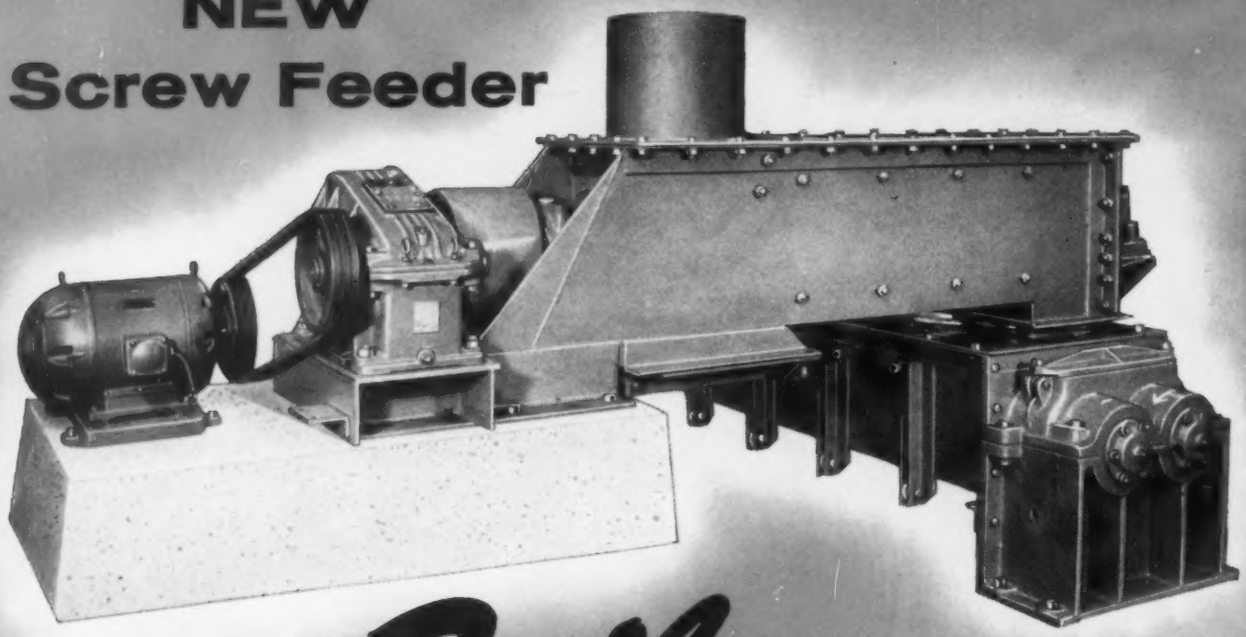
NEW Screw Feeder



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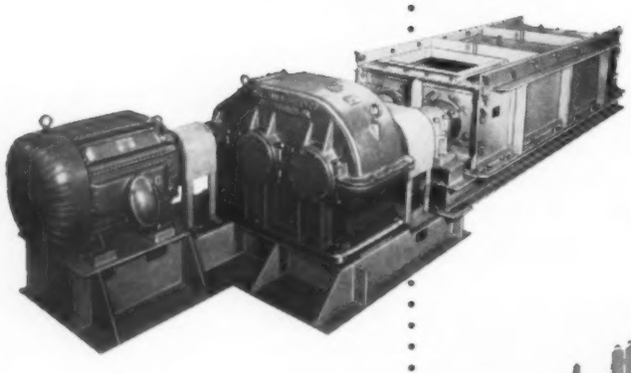
EVEN MORE EFFECTIVE IN SINTERING PLANT AND BLAST FURNACE DUST CATCHER SERVICE



This Bailey Double Shaft Pug Mill is equipped with a double helical gear reduction unit. Types of Bailey Pug Mills available include single and double shaft types, with direct or rope drives.

The new Bailey Screw Feeder is effective for flow regulation and conveying of flue dust, ore fines and various other materials. An outstanding feature is that it maintains uniform flow, even when irregular feeding may be caused by "hanging" of material in dust catcher or a sudden furnace "slip." The feeder speeds the sintering process and assures substantial savings through reduced handling costs.

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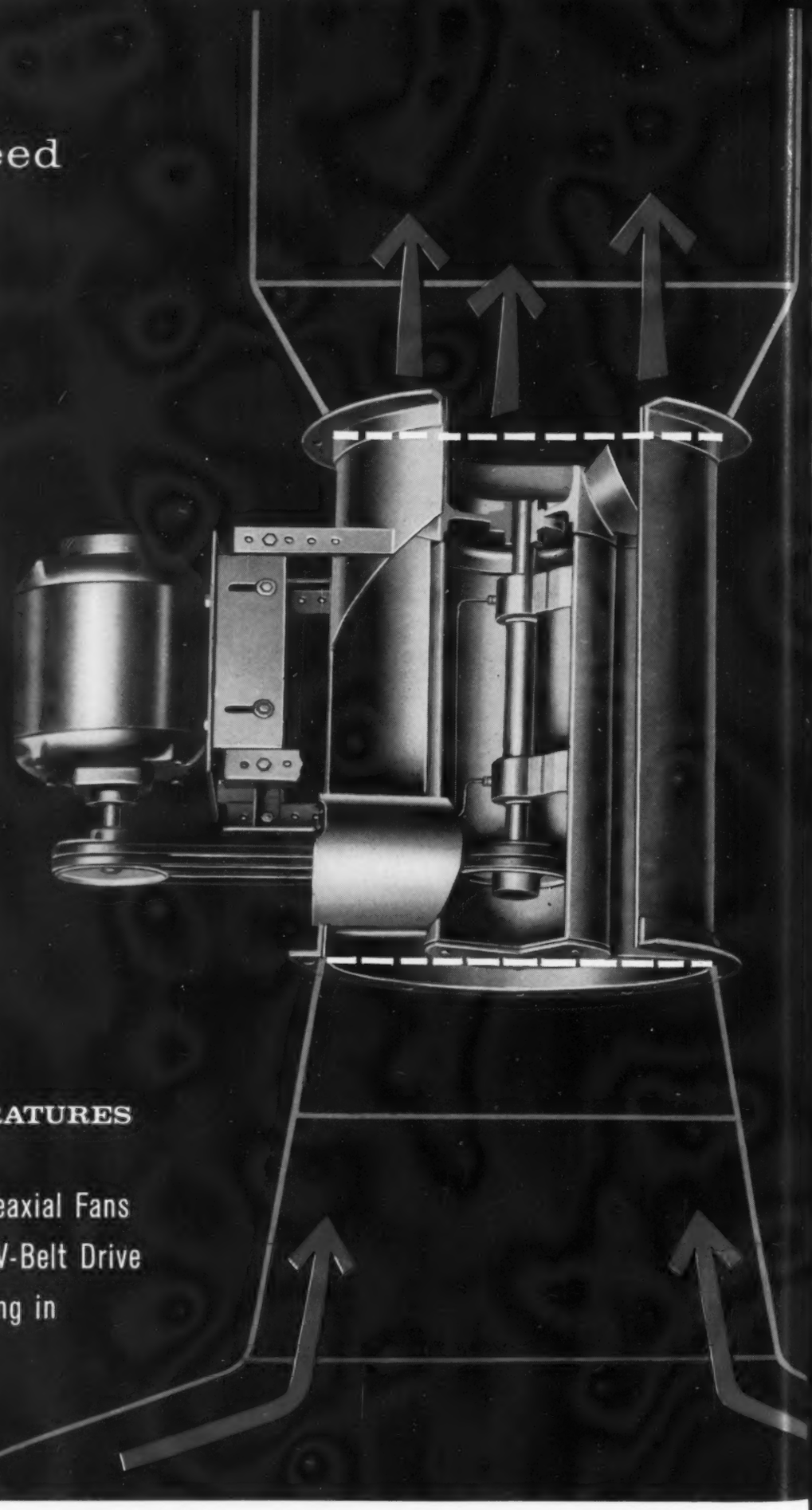

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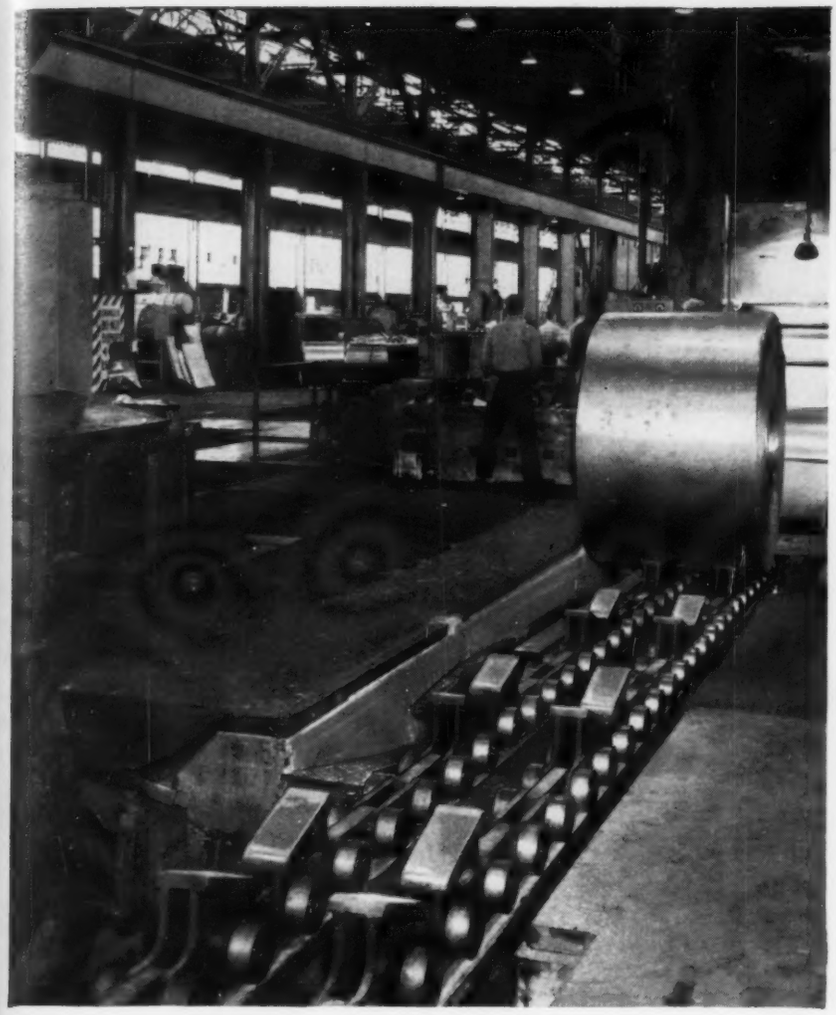

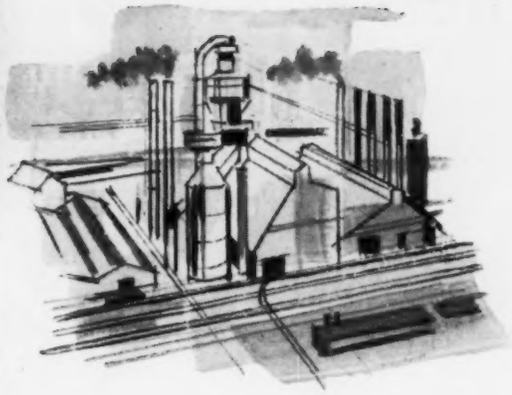

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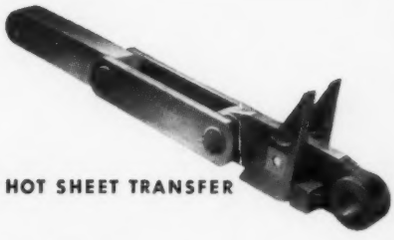

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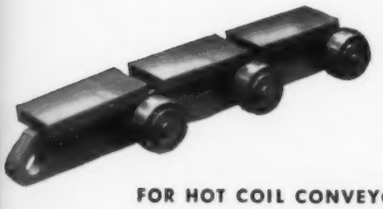
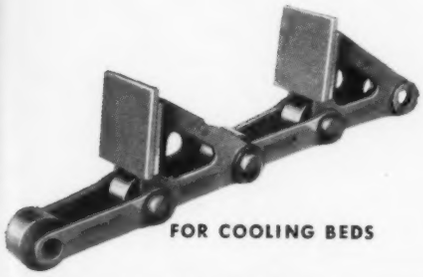


FOR HOT COIL CONVEYORS

FOR DRAW BENCHES



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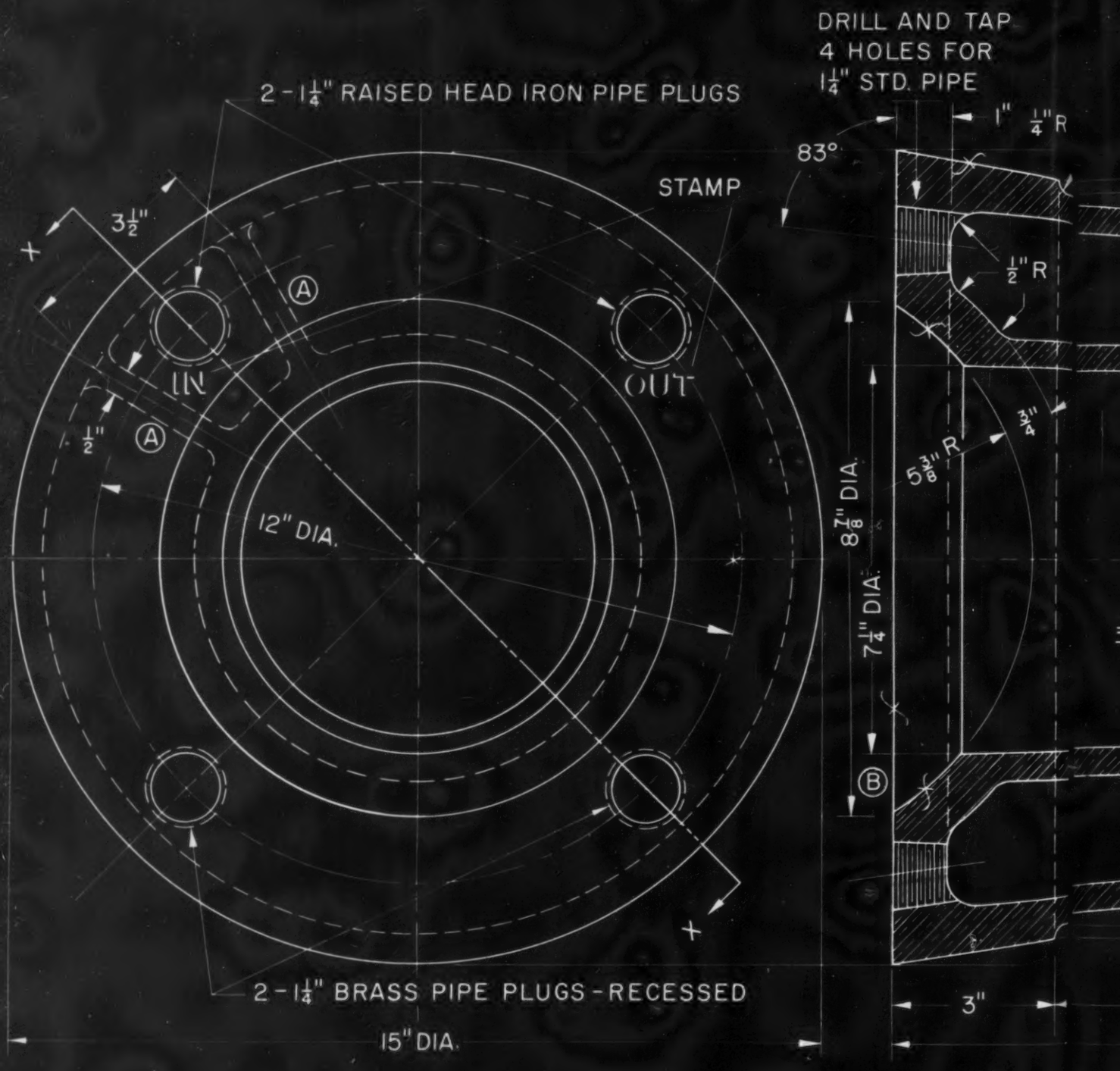
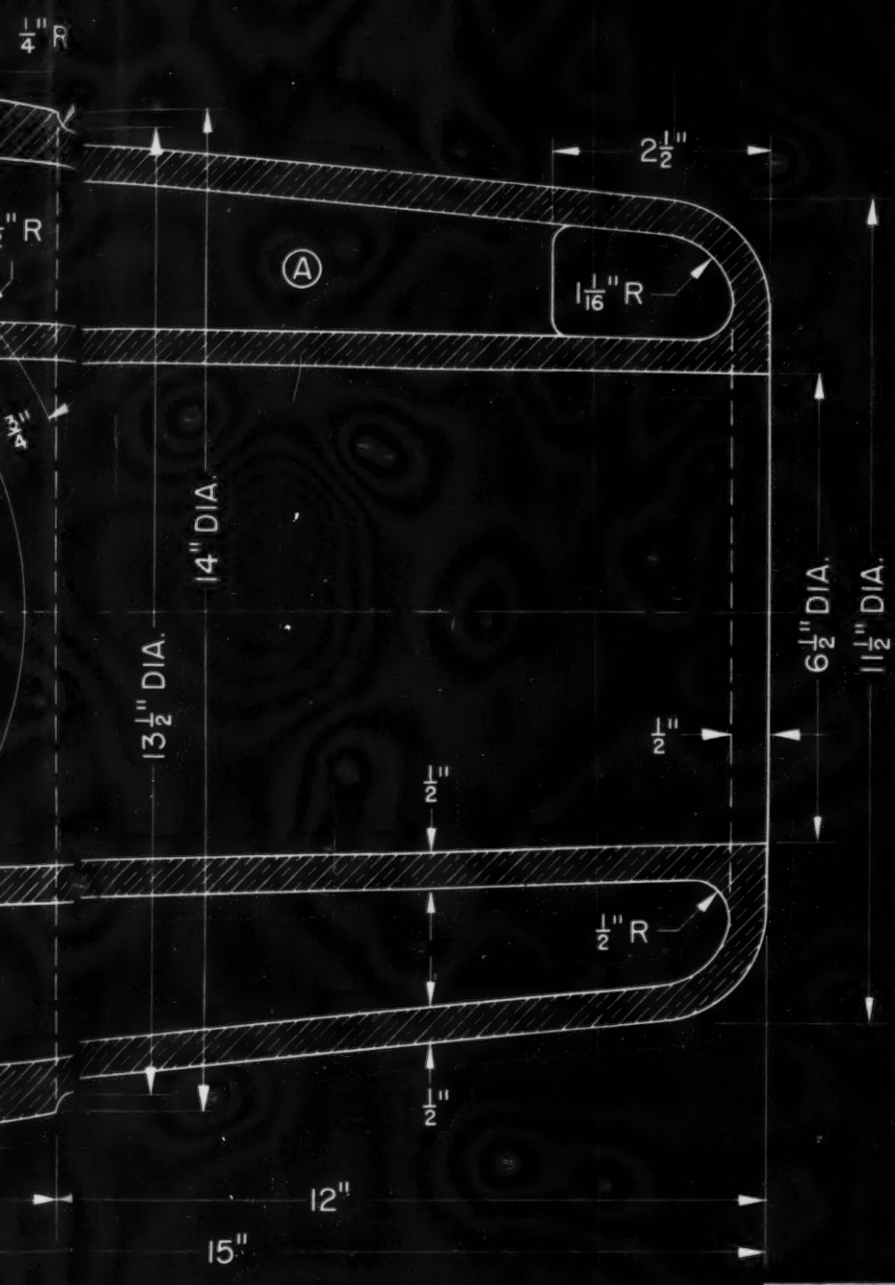
FILE: BLAST FURNACE - COPPER TUYERE



RIGGING (PATTERN) NO. 3462

PATTERN	3462
SHELL BOX	1777
PLUG	3020
CENTER BOX	3020
PRINT	3020



SECTION X-X

PRODUCTION SPECIFICATIONS

MATERIAL: Electrolytic Copper

STANDARD INSPECTION:

1. Conductivity (I.A.C.S.). Heat Only.
2. Hydrostatic Test - 100 psi
3. Dimensional Check - Gauge
4. X-Ray - Pilot Castings

SPECIAL INSPECTION - See Shop Order for Customer Specifications:

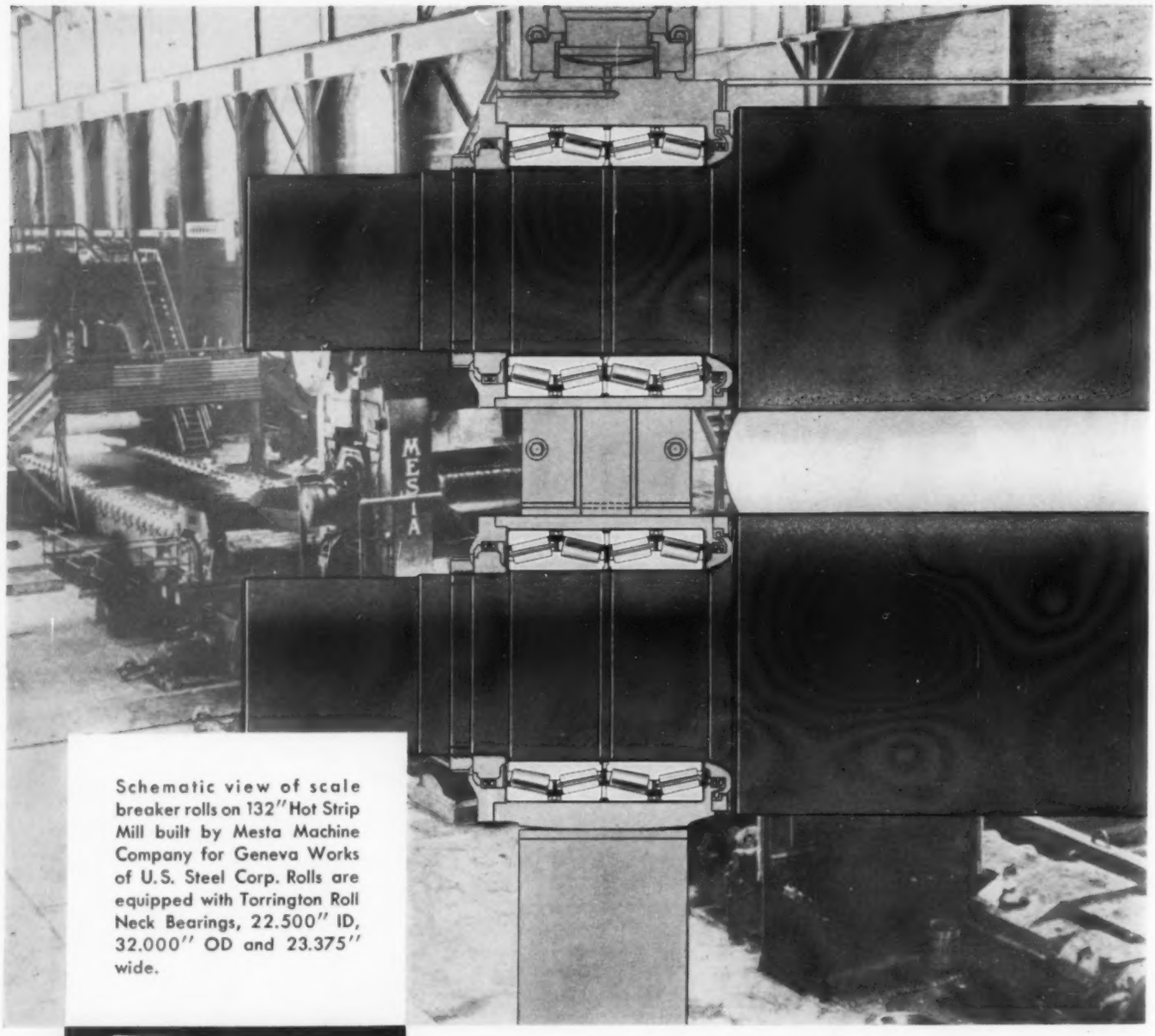
1. Conductivity Report on Each Tuyere
   - a - 70% min. (I.A.C.S.)
   - b - 80% min. (I.A.C.S.)
   - c - 90% min. (I.A.C.S.)
2. Steam Test - 100 psi
3. X-Ray Test - Individual Tuyeres
4. Certified Chemical Analysis

REFERENCE DRAWINGS:

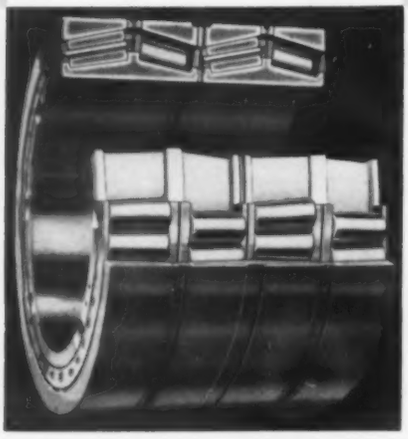
K - 55884 – 8½" x 15"
L - 56976 – 7" x 15"
K - 56961 – 7" x 12"
K - 56820 – 6½" x 12"
L - 57164 – 6" x 15"
K - 57081 – 6" x 12"
K - 56889 – 5½" x 15"
K - 56188 – 5½" x 12"
K - 56846 – 5" x 15"
K - 57180 – 5" x 12"
K - 56590 – 4½" x 12"

REV.	DESCRIPTION	DATE	DR.	CK.
B	ADD ∫ BUTT END	3/6/57	H.W.	J.S.
A	RIBS ADDED	2/1/57	H.W.	J.S.

DRN. H.W.	NATIONAL BEARING DIVISION	
CHK. J.S.	717-D GRANT BLDG., PITTSBURGH 19, PA. PLANT: MEADVILLE, PA.	AMERICAN Brake Shoe COMPANY
DATE 1/21/56		
SCALE 3/8" = 1"	6½" X 15" STANDARD TUYERE	
CUSTOMERS NO. E-66293	SHEET 1 OF 1	L - 56432



Schematic view of scale breaker rolls on 132" Hot Strip Mill built by Mesta Machine Company for Geneva Works of U.S. Steel Corp. Rolls are equipped with Torrington Roll Neck Bearings, 22.500" ID, 32.000" OD and 23.375" wide.



Torrington Roll Neck Bearings give maximum capacity with minimum cross section

Torrington Four-Row Tapered Roller Bearings take heavy radial and thrust loads in stride on the roll necks of two-high scale breaker at the Geneva Works of U.S. Steel Corp.

These bearings are made of finest quality electric furnace steel, toughened and case-hardened through seven heat-treating cycles. This enables Torrington Engineers to design the bearing geometry within a minimum cross section. Maximum load capacity and higher roll neck strength are obtained.

You will find that Torrington Roll Neck Bearings pay off in higher tonnage, reduced maintenance and down time. **The Torrington Company, South Bend 21, Ind.—and Torrington, Conn.**

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Foreign Digests

Complete translations from which these condensations were prepared are available from Henry Brutcher, P.O. Box 157, Altadena, Calif., to whom all correspondence should be addressed.

"PROPERTIES OF FLUXED SINTER"

by N. L. GOL'DSHTEIN and N. S. KHROMENKO, Mining and Metallurgical Institute, Magnitogorsk. (Translation No. 4386 from Stal, vol. 18, 1958, No. 7)

Δ THE purpose of the investigation was to determine the amount of combined iron oxides in various sinters by reduction at intermediate temperatures and by throwing light upon the kinetic aspects of the process of reduction. About one hundred production samples were studied. These were mainly fluxed sinters of various compositions produced from Magnitogorsk and Krivoi Rog ores.

Conclusions from the investigation follow:

1. Iron oxides in sinters exist in two distinct states—"free" and "combined."

2. The combined iron oxide content is mainly governed by the amount and composition of the gangue materials in the sinter and does not really depend on its FeO content if the latter does not exceed 22 to 25 per cent.

3. The oxygen content of the combined iron oxides in such sinters does not usually exceed 10 to 12 per cent, irrespective of basicity.

4. The combined iron oxides in the blast furnace inevitably undergo direct reduction (in indirect reduction removing less than 62 to 67 per cent oxygen, only part of the free oxides reacts).

5. To estimate the reducibility of sinters, it is recommended to use kinetic (rate) characteristics determined when not more than 70 per cent oxygen is removed from the iron oxides (a range of 30 to 50 per cent oxygen removal is better).

6. The reducibility of sinters is determined mainly by the condition of the free iron oxides—their adsorptive activity and the extent to which they are available for reacting with the gases. These factors depend chiefly on the temperature of the sintering process and the amount of gangue and on the estimated proportion of divalent iron in the total iron content of the sinter.

7. The amount of fayalite or other complex iron-bearing minerals in the sinter bears no direct relationship to reducibility as a kinetic characteristic. A connection between these factors is observed only with an extremely high sintering temperature at which the proportion of divalent iron and the amount of combined oxides are simultaneously increased.

8. Variation in sinter basicity has little direct effect on reducibility. The relationship between these factors which is, however, observed in practice is due to the fact that an increase in basicity, as a rule, is accompanied by a lower sintering temperature.

"ON THE MECHANISM OF HARDENING OF IRON-ORE PELLETS"

A. N. POKHVISNEV and B. A. SAVEL'EV, Moscow (formerly Stalin) Institute. (Translation No. 4161 from Stal, vol. 18, 1958, No. 2)

Δ A COMPREHENSIVE investigation of the process of obtaining pellets was made on Krivoi-Rog magnetite concentrates obtained by beneficiation of quartzites at the Southern Ore Concentration Combine (YuGOK). Krivoi-Rog hematite ore was also used for making pellets, as was pure ferric oxide powder containing up to 50 per cent of minus 270 mesh fraction.

Pellets were prepared, as far as possible, with a uniform diameter of $19/32$ in. by the preliminary extrusion method developed in the Moscow Steel Institute.

The pellets were fired in a tubular furnace under varying conditions. Minimum crushing load was taken as a criterion of pellet strength.

Conclusions reached through the investigation are: The firing of pellets made from magnetite concentrates must be carried out at a maximum possible speed and complete oxidation of magnetite to hematite, in high oxygen atmosphere, and at high temperature. The firing temperature must be raised to the established limit for a sufficient length of time to allow the completion of the process of recrystallization of the hematite grains obtained by oxidation of the magnetite. This process takes place both in an oxidizing and in a neutral atmosphere.

The period of firing may vary from ten to thirty minutes depending on the chemical and the screen analyses of the concentrates, firing temperature, oxygen content of the atmosphere, throughout speed, pellet dimensions, nature of the additions, "shock" temperature of the pellets, etc.

The firing temperature for magnetite concentrates must be 2190

to 2370 F, depending on the nature of the concentrate gangue.

For pellets made from hematite concentrates, the duration and temperature of firing may be reduced if the ore is ground prior to beneficiation; failing this, the process of hardening such pellets begins only above 2370F. No excess of oxygen is required for firing hematite concentrate pellets.

"DESIGN OF A VACUUM INSTALLATION FOR POURING OF INGOTS OF UP TO 120 TONS"

by V. K. NOVITSKII. (Translation No. 4372 from a Collection of Papers Titled "Use of Vacuum in Metallurgy," Moscow, 1958)

△ THE Central Research Institute for Technology and Heavy Engineering and the Urals Heavy Machine Building Works have developed a technique for vacuum pouring large forging ingots. A small installation was constructed for vacuum casting of ingots, weighing up to 33 net tons. For casting ingots weighing up to 130 net tons, a large setup has been designed. It consists of a chamber and a pump set with a system of tubes and a cooler for cooling and filtering the gases.

The chamber itself is a cylinder 16 ft inside diameter and about 21 ft high without cover, of steel plate $^{25}/_{32}$ in. thick. It is all-welded and completely leak-tight.

The cover of the chamber is one of the most heavily loaded parts of the installation, since it has to sustain a load of about 275 net tons, made up of the pressure difference when the chamber is evacuated, the weight of the ladle with the liquid metal, and, of course, its own weight.

On the upper face of the cover there is a plate $1^{37}/_{64}$ in. thick, on which is mounted a water-cooled ring with a rubber gasket 2 in. wide, making the joint between cover and pouring ladle.

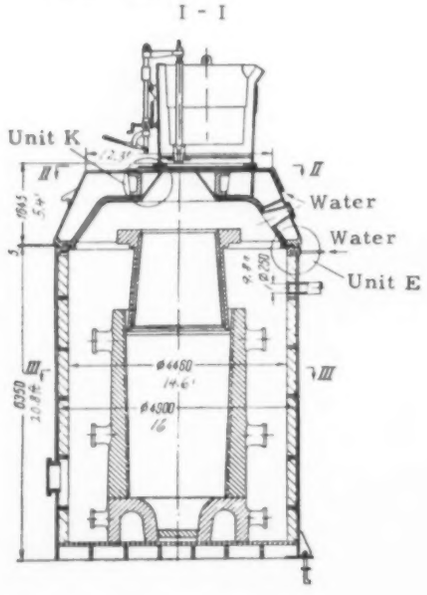
The ladle is a 22-net ton teeming ladle of usual type. To its lower face a flange is welded, with an annular projection sealing on the rubber gasket on the upper face of the cover.

In the nozzle under the stopper there are two aluminum or brass plates, one over the other, additionally sealed with waterglass. They serve as a vacuum seal when the ladle is empty.

The evacuating system consists of seven vacuum pumps of total capacity about 53,000 cfhr at atmospheric pressure.

A cooling-filtering unit is intended for cooling the gases sucked out of the chamber and removing dust from them to prevent premature breakdown of the pumps. It consists of a cylinder about $11\frac{1}{2}$ ft high and $23\frac{1}{2}$ in. in diameter, in which water circulates around a series of longitudinal tubes, through which the gas being pumped out passes.

Figure 1 — Vacuum chamber for pouring large ingots.



OTHER AVAILABLE TRANSLATIONS

"Longer Life of Sleeves of Backing-Up Rolls for Cold-Rolling Mills," by M. M. Kobrin and K. V. Shishokina, Central Research Institute for Engineering Technology, "Metallovedenie i Obrabotka Metallov," May, 1958. Study of ways of preventing brittle fracture (running along a generating line) of sleeves on built-up backing rolls for cold mills are covered and also steel composition and heat treatment of sleeves in industrial practice. Lack of information on the tendency of sleeve steel to delayed failure and testing procedure developed by authors to determine this tendency: shape and dimensions of test bars; results of short-time and long-time stressing are discussed. Conclusions are drawn from results as to suitable heat treating conditions. (Translation No. 4224)

"Hanging of Stock in Blast Furnaces Operated on Oxygen-Enriched Blast," by S. K. Trekalo, Stal', vol. 18, 1958, No. 6. Comparative analysis of operating data on two blast furnaces for causes of frequent hanging of charge when on oxygen-enriched blast. Effect of blast humidity; blast volume and temperature; particle size distribution of ore and sinter, especially the amount of ore fines; pressure drop of gas along blast furnace height; change in furnace lines and reducibility of charge as affecting the passage of the gases through the stock column. Effect of changeover from ordinary air to oxygen-enriched blast upon peripheral gas flow and volume of gases. Results of analysis of variation in hydrogen content of hearth gas. Ways of slowing down the gas flow near the wall. Measures recommended for dependable smooth working of blast furnaces operated on oxygen-enriched air and producing either basic iron or foundry pig iron. (Translation No. 4301)

"Interaction of Iron Ores with Methane in a Fluidized Bed," K. P. Lavrovskii et al. Doklady Akademii Nauk SSSR, vol. 112, 1957, No. 4. Applicability of advances in fluidizing reactor technology to production of sponge iron. Laboratory setup; experimental procedure and results. Trials in larger setups, including a 22-lb pilot plant, confirming the laboratory experiments. Conditions under which a fluidized bed for reduction of various ores can be maintained at 1560 to 1650 F without the solid particles sticking together. Possibility of obtaining the hydrogen needed for the reduction process from methane-containing reducing gases. (Translation No. 4465)

"Problems of the Use of Vacuum in Metallurgy," A. M. Samarin. Moscow, 1958. Introductory chapter to a collection of papers giving (a) a general evaluation of the status of vacuum melting, pouring and equipment in the Soviet Union; (b) the highlights of some worthwhile Russian work; and (c) a comparative appraisal of the present state of the art in the USSR as against some Western countries. (Translation No. 4361)

YOUNGSTOWN PIPE TRAVELS via ENTERPRISE

ENTERPRISE Pipe Handling Machinery in Youngstown Sheet and Tube Co's. New Mill:

1. Stretch Mill Decelerating Conveyor
2. Inlet Table
3. Heavy-Duty Middle-Cut Saw
4. Cooling Racks
5. Discharge Conveyor

ENTERPRISE equipment begins inside the furnace with water-cooled rolls feeding billets to the stretch mill. The decelerating conveyor, 283 feet long and consisting of 63 individually driven rolls, takes the pipe from the stretch mill at 1250 fpm. Limit switches decelerate the entire line and start rotation of 33 star-wheels that discharge the pipe via an inclined ramp and rotating cams to the centering rolls. Centering for the hot saw is accomplished by 206 feeler limit switches, and 33 rotating turrets carry the pipe through the saw and dump it on the chain drag cooling bed. The lead and trail crops are picked up on a double line of individually-powered rolls, and discharged down a ramp to the transfer conveyor which completes the trip to a straightening machine. A rotary crossover bridges a set of rolls which are used only when cooling and sawing are unnecessary. This new mill at Youngstown Sheet & Tube Co. delivers 2⅜" to 5½" O.D. in lengths of from 75 to 150 feet.

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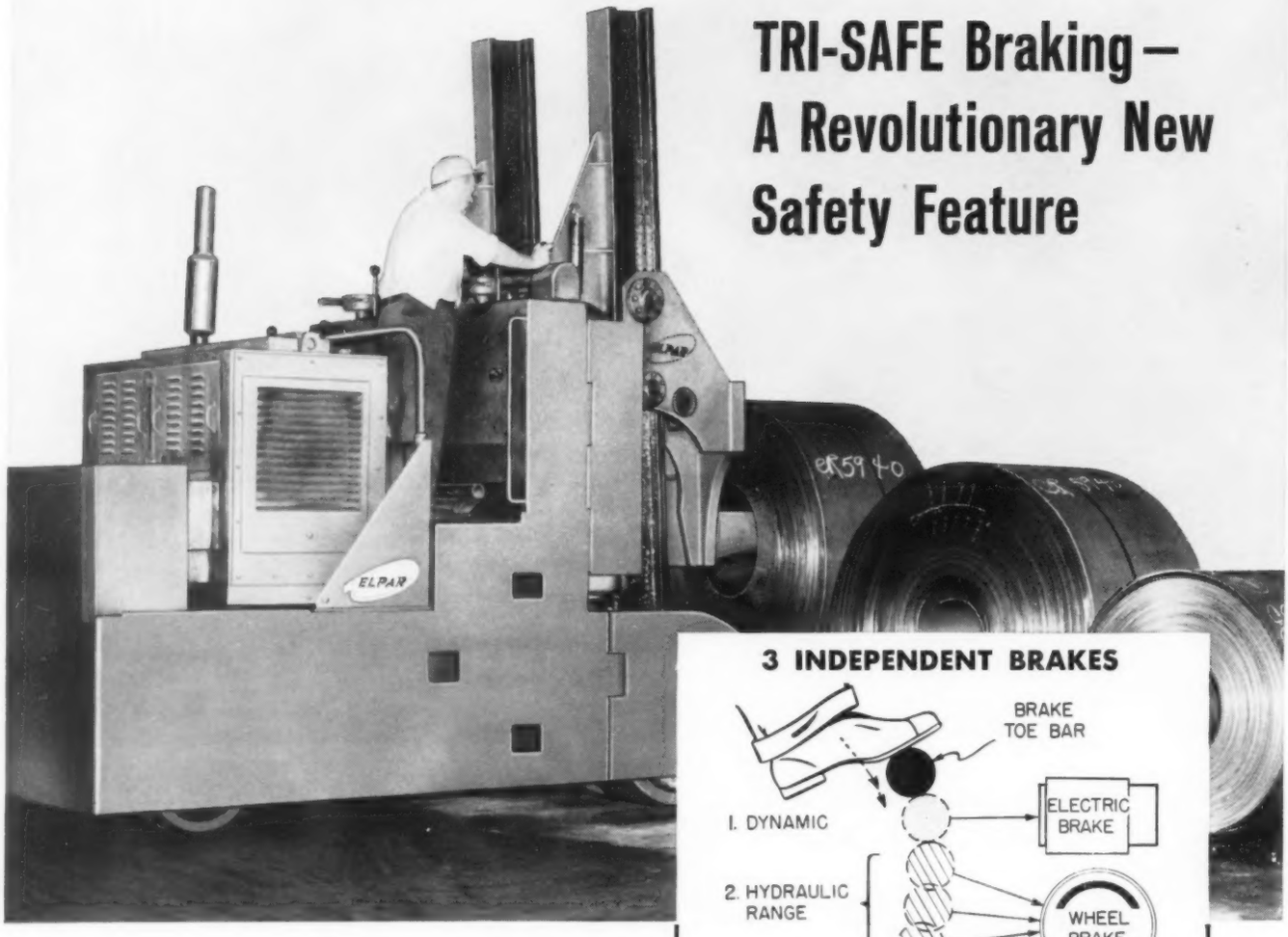

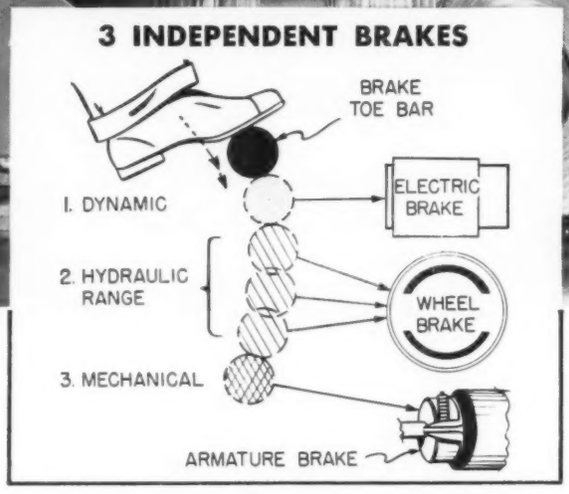

...Now on all ELPAR Heavy Duty Ram Trucks

• "Putting on the brakes" can be a major undertaking with a 60,000 pound truck plus a 50,000 pound load! It's particularly hazardous on the rough and tumble handling jobs found in steel mills.

To end ram truck braking hazards, ELPAR developed the new TRI-SAFE brake system. Here's how it works: When the operator steps on the brake toe bar, the main power circuit is cut and dynamic braking slows the truck. In position two, the power hydraulic brakes are applied to bring the truck to a smooth controlled stop. In emergencies, the operator simply follows his natural reaction — pushes the toe bar to the floor applying a positive, fast acting mechanical brake. Note that the toe bar extends across the entire width of the truck permitting brake operation from any postion in the operator's compartment.

TRI-SAFE braking not only provides three-way brake safety, but it cuts brake wear too.

Dynamic braking slows the truck, thus reducing the load on hydraulic brakes. Result: brake shoe life is increased up to 4 times.

If you are interested in greater handling safety it will pay you to investigate Tri-Safe Braking. You can get it on any ELPAR heavy duty ram truck from 12,000 to 100,000 lbs. capacity.

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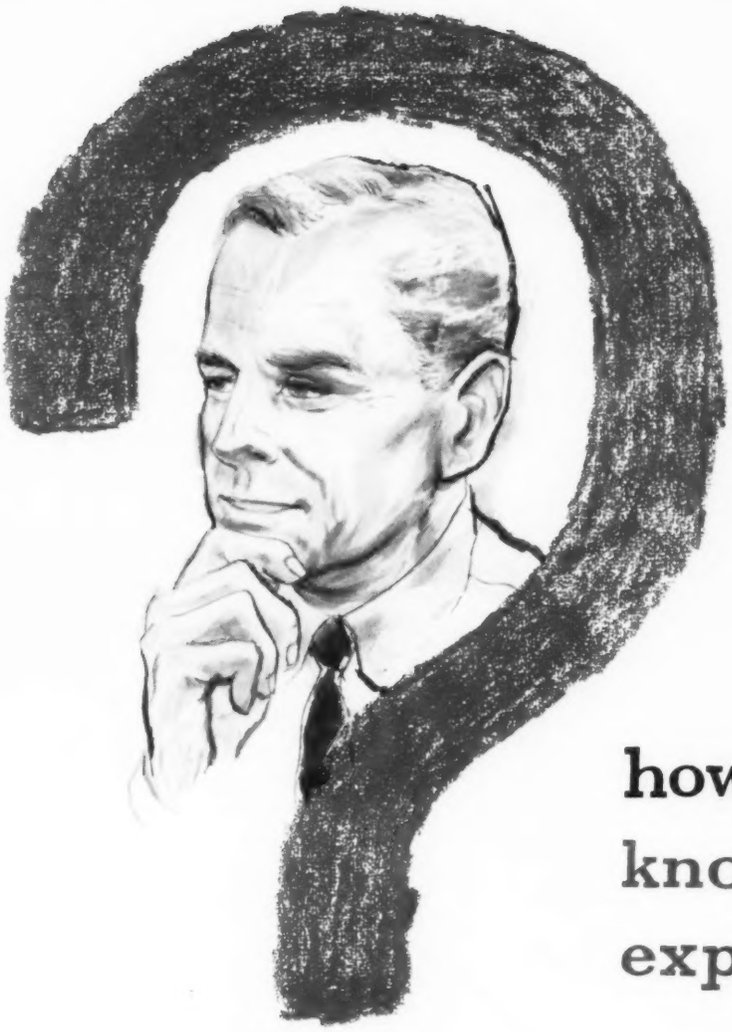

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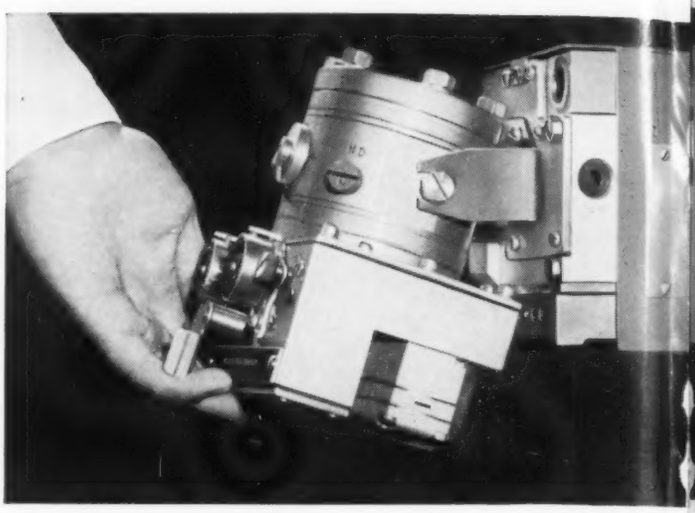


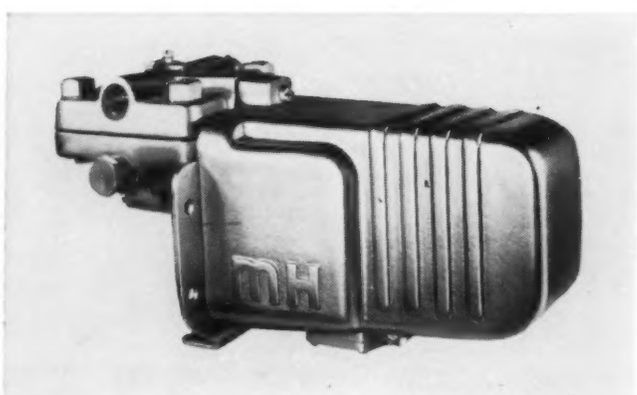
***TEL-O-SET* CONTROLLER** is conveniently mounted on back of instrument case, has quick-connect switch permitting both fast mounting and easy removal of the unit while process remains on control. The control unit can be separately mounted in any remote location if process demand requires.

BELLOWS FLOW METER is ideally suited to fuel flow metering, unequalled for accuracy, stability and versatility. Convenience features include fast range changing in field, quick calibration and adjustment, easy cleaning and servicing.

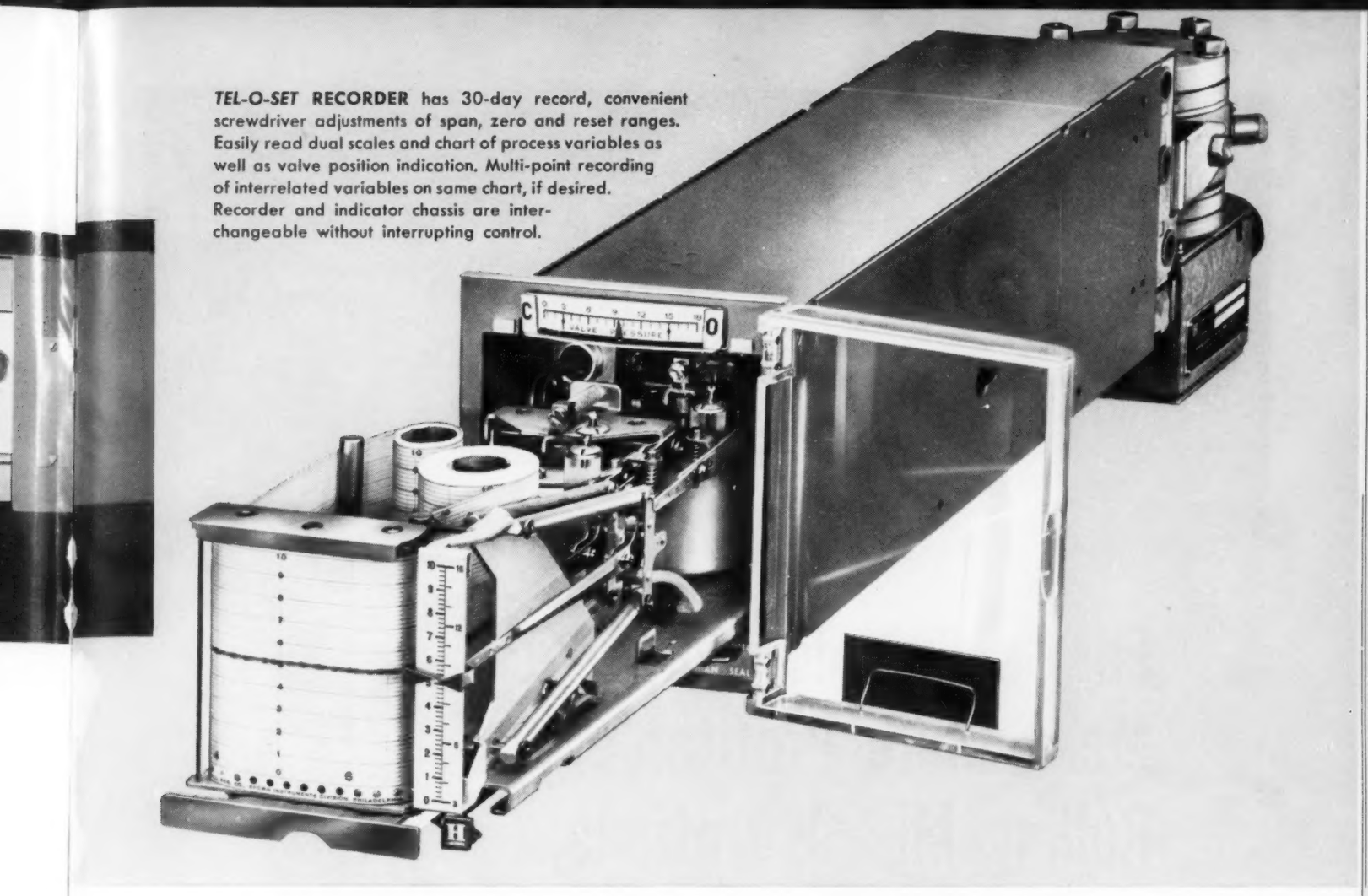
Control...

with advanced

***TEL-O-SET* MV/P TRANSMITTER** for temperature measurement, converts any millivolt signal to a standard 3-15 psi pneumatic signal.



DIFFERENTIAL CONVERTER transmitter offers many advantages in low pressure air flow applications. A mercuryless manometer which operates on a pneumatic force-balance principle, it's accurate within ± ½% of full scale. Range continually adjustable in field. Excellent sensitivity obtained over distances as great as 1,000 feet.



***TEL-O-SET* RECORDER** has 30-day record, convenient screwdriver adjustments of span, zero and reset ranges. Easily read dual scales and chart of process variables as well as valve position indication. Multi-point recording of interrelated variables on same chart, if desired. Recorder and indicator chassis are interchangeable without interrupting control.

every process variable...
TEL-O-SET miniature instruments

Simplify control of your process, and gain the extra savings that come with *Tel-O-Set* miniature pneumatic instruments. The same instrument can be used to record, indicate and control virtually any variable—temperature, pressure, flow, fuel-air ratio.

This interchangeability means important economy for you: Process operations can be changed without obsoleting your instruments. Personnel training time is minimized. Parts inventory is kept low.

Tel-O-Set instruments are accurate, sensitive, have true linear calibration, and respond swiftly to process changes. No miniature pneumatic instrument can match them for ease and economy of maintenance.

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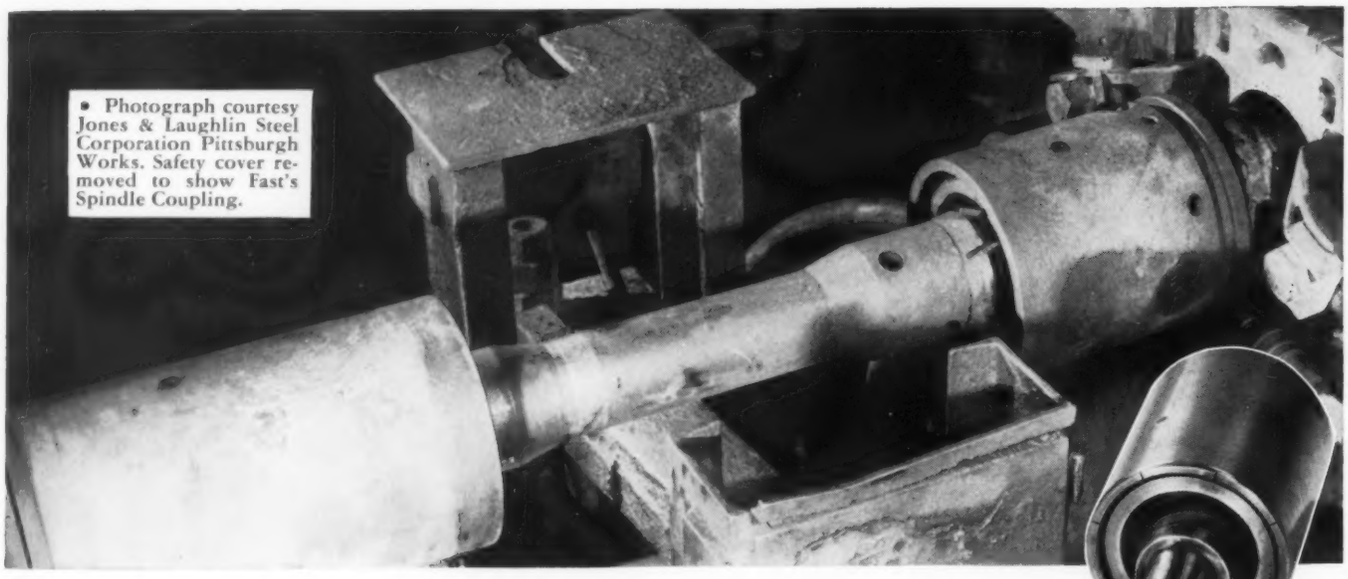

• Photograph courtesy Jones & Laughlin Steel Corporation Pittsburgh Works. Safety cover removed to show Fast's Spindle Coupling.

Fast's Spindle Couplings Mean More Profitable Rolling Mill Operations

★ *Up to 50% Less Down-Time*
★ *Quicker Disassembly*
★ *Bigger Savings on Maintenance*

The quick-disconnect and reliability features of Fast's Spindle Couplings may reduce down-time as much as 50%. Figured in dollars, this permits savings in production time in most rolling and blooming mill applications which can amount to thousands of dollars a month.

The new tooth configuration of Fast's Spindle Couplings compensates for a relatively high amount of misalignment with a minimum of backlash. It also permits constant angular velocity of the rolls which results in a marked improvement in the quality of the end product. Fast's Spindle Couplings are made of all steel construction with a metallic segmented conformable seal . . . completely self-contained and self-lubricated. They withstand the most rugged operating conditions, giving years of trouble-free service with only a minimum of maintenance.

Koppers' 38 years of experience in the coupling industry guarantees the right coupling engineered for a given application. To solve your rolling mill coupling problem write to KOPPERS COMPANY, INC., Fast's Coupling Department, 5004 Scott Street, Baltimore 3, Maryland.

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BRISTOL'S

Instrumentation News

• *News of instrumentation and automatic control in industrial heating and metallurgy* •

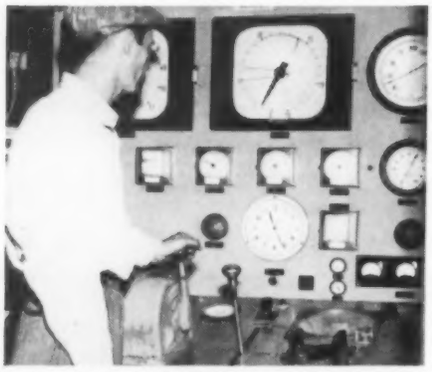
Instruments help turn out casting cores at 7 tons/hour

Engine blocks for Ford and Mercury automobiles are cast with strictest attention to accuracy and structural quality at the Cleveland foundry of the Ford Motor Company, Brookpark, Ohio, just outside Cleveland.

Yet these rigorous requirements must not impede the smooth flow of the production line. That's one reason Ford installed this battery of Bristol Dynamaster* instruments.

Another: In the early days, core baking used to be an all-night process. Cores were of fine quality, but the output was too low for present-day production lines. The new core baking method turns out top quality cores at the rate of 7 tons an hour. Bristol instruments automatically hold the baking temperature to 450° ± 5°F. And, in emergencies, allow faster processing by raising the temperatures and increasing conveyor speed.

First oxygen steel plant uses Bristol controls



Bristol round chart Dynamaster* Instruments (top) and Bristol Metagraphic miniatures (center row) play a big part in controlling oxygen steel-making at Dominion Foundries & Steel, Ltd.

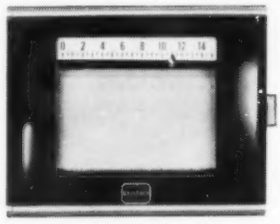
When Dominion Foundries & Steel, Ltd. (Dofasco), at Hamilton, Ontario, first introduced this method of steel-making to the North American Continent, they chose Bristol instruments and controls (above) to supervise the most critical steps in the process.

These include oxygen pressure and flow (current rate and total), lance position, lance cooling water temperature, flow, and pressure as well as various other temperatures.

The big advantage of oxygen steel-making is the lower original investment in equipment. Only about 50% of the equipment costs of competitive processes is required and operating costs are no higher, with equal or better product.

Furnace, oven, dryer— Bristol controls them all

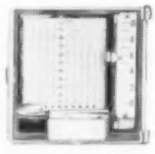
Whatever your industrial heating application, you can find a Bristol instrument or instrument system to provide precision indication, recording or automatic control. The following instruments, in almost innumerable variations, are typical of the truly complete Bristol instrument line.



Bristol's Dynamaster* Potentiometer Pyrometers come in round or strip chart models, provide electronic recording, indication, and electric or pneumatic control, including high-low contact, proportional, time-program and many combinations. The outstanding instrument for maximum precision.

Bristol Millivoltmeter Pyrometers. Both indicating and controlling models available. Controlling models utilize unique Bristol Free-Vane* principle that completely eliminates relay "chatter" or "flutter." High-low contact and proportional models available in a wide variety of combinations.

Bristol Miniature Instruments – Bristol is the only company offering a complete line of instruments in both miniature *and* full-size for all recording, indicating and control applications, both electronic and pneumatic. True plug-in construction. Ideal where panel space must be conserved.



*T. M. REG. U. S. PAT. OFF.

Write for complete data on Bristol instruments for your furnace, oven, dryer or kiln. And remember, Bristol makes a complete line of thermocouples and pyrometric accessories. The Bristol Company, 123 Bristol Road, Waterbury 20, Conn.

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Formerly, slip rings were reground every 6 to 8 weeks!
STILL GOING STRONG
STILL GOIN' STRONG
STILL GOIN' STRONG
STILL GOING STRONG
MAINTENANCE DEPARTMENT

Slip ring motor trouble ended here May 23, 1958!

(the day they switched to NATIONAL TRADE MARK Brushes)

LOUIS J. ESPOSITO

Scene: a busy mid-western ore washing plant. *Problem:* threading and grooving on slip ring motors. Two months seldom went by without an expensive regrinding job on every motor, says "National" Carbon Brush Man Louis J. Esposito.

Lou first determined the cause of the trouble by analyzing workloads and the resulting current requirements. His recommendation: "National" Brush Grade AY. *Result:* no more slip ring trouble.

Not only did a costly problem disappear, but plant management also was able to release service facilities for better maintenance elsewhere.

What about *your* brush problem? You can easily have expert help. There's a specially trained "National" Carbon Brush Man as close as your telephone. Call him today, or if you prefer, write to National Carbon Company, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y.

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NEW AAF Cleans air

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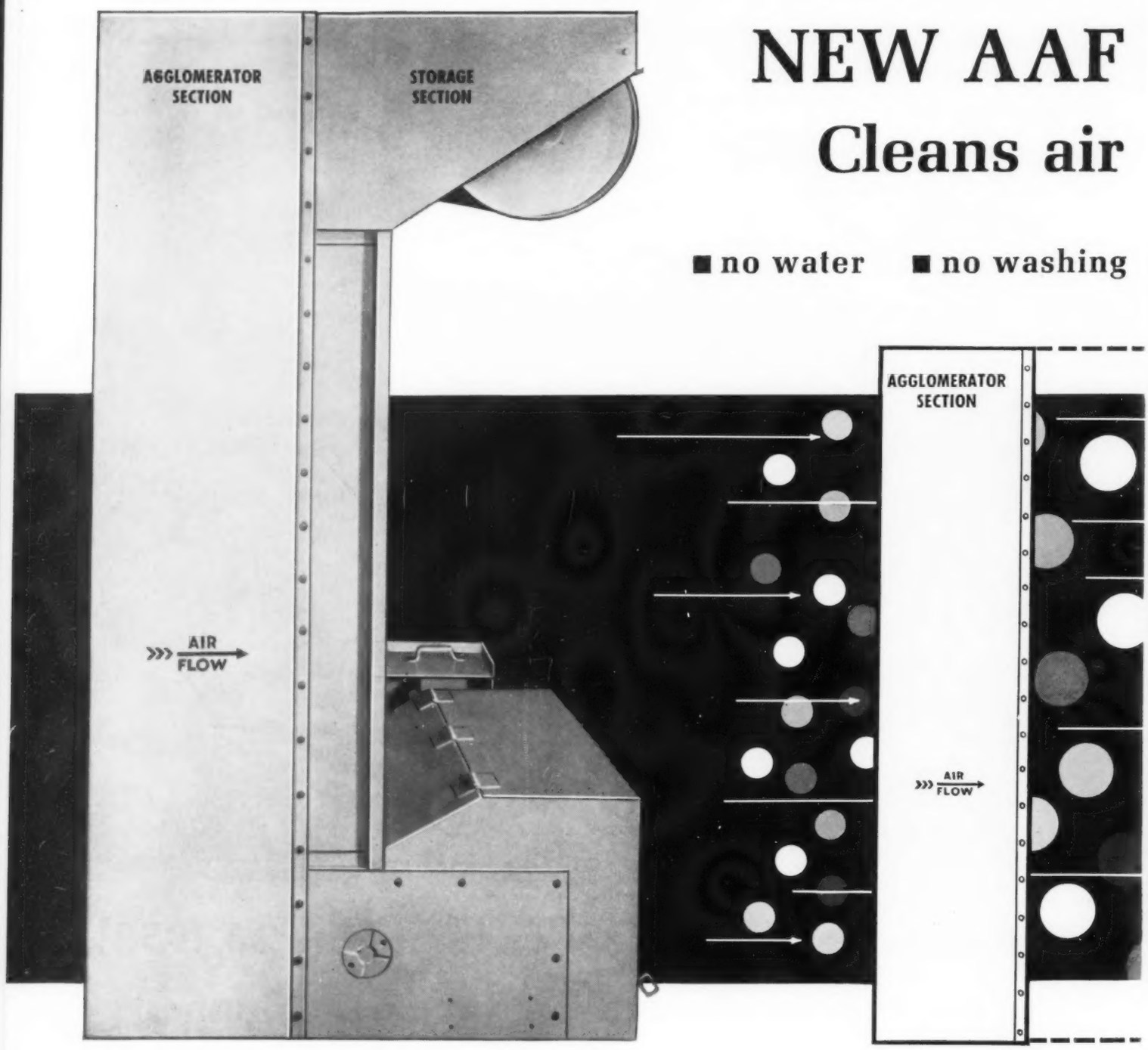

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- **the efficiency of an electrostatic precipitator, and**
- **the minimum maintenance of an automatic-renewing, disposable media air filter,**

both in one space-saving unit!

This revolutionary new air cleaner is the Rollotron. Its unique operating principle is shown in the exploded "flow diagram" illustration.

In overall size, the Rollotron requires no more space than any other electrostatic precipitator. Regardless of unit height or width, depth is only 39"!

1 TRAP THE DUST ELECTRONICALLY!

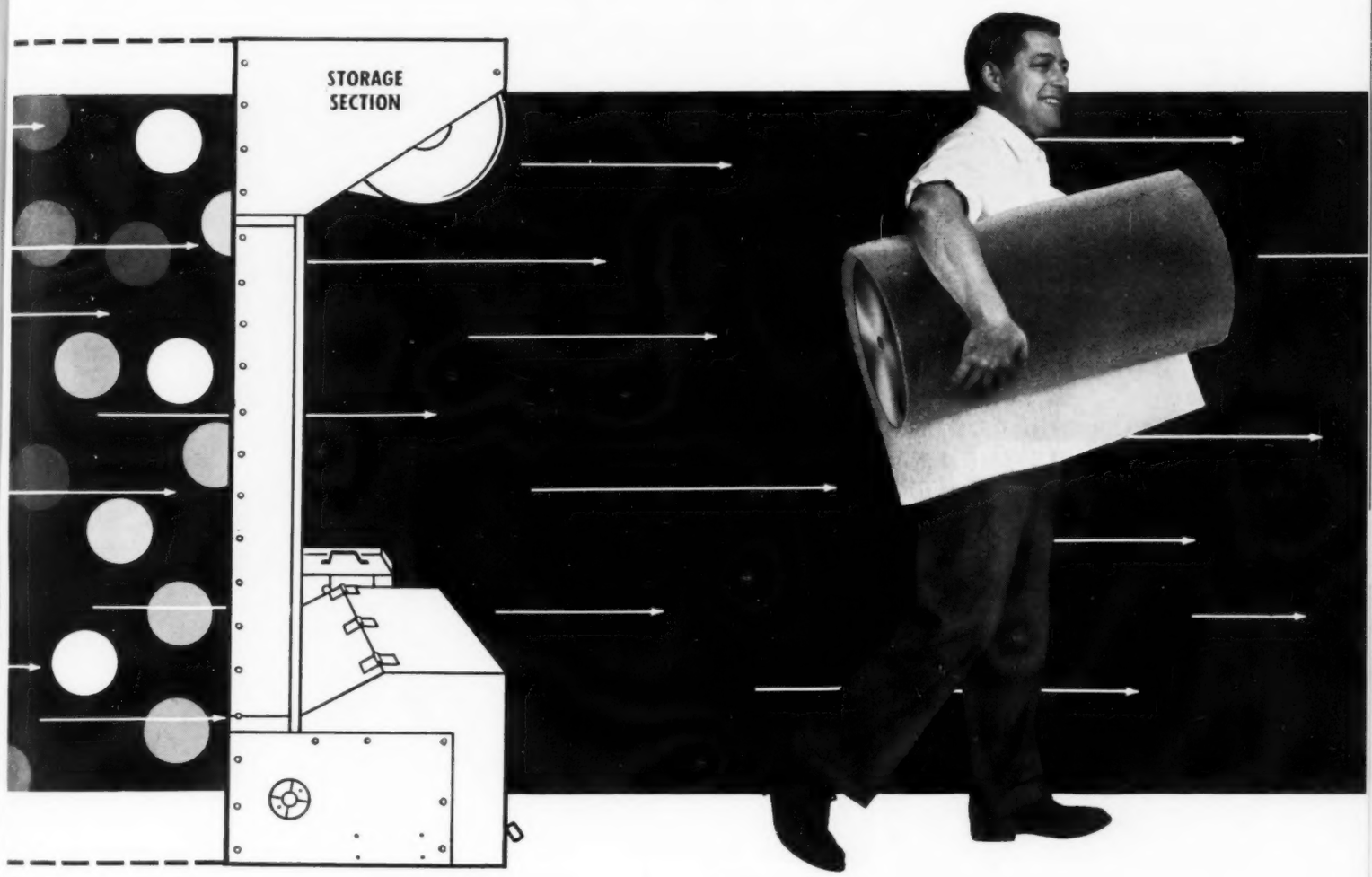
Minute dust particles are electrostatically attracted and adhere to each other on the *dry* plates of the agglomerator section. As the trapped dust particles build up (agglomerate) on the collector plates, the "mass" increases until the accumulation is swept off the plates by the air stream. Dirt is then carried onto the bonded glass fiber media of the storage section.

Maintenance on precipitator section? Virtually none. No oiling, no washing, no water, no freezing, no drains.

ROLLOTRON

electronically, rolls away the dirt!

■ no freezing problems ■ no drains ■ no oiling of plates



2 ROLL IT UP AUTOMATICALLY!

A bonded glass fiber "blanket" is fed automatically down the face of the storage section from a roll at the top. The used media—and accumulated dirt—are wound tightly into a compact roll at the bottom.

Maintenance? Simply replace the soiled roll with a clean one—an operation as simple as changing the film in your camera! In normal service, this is required only about once a year! The Rollotron makes scheduled maintenance a thing of the past!

3 TAKE IT AWAY PERIODICALLY!

With quick, easy media replacement, the Rollotron is again ready to give maximum air cleaning—*electrostatic* air cleaning—for months to come!

For complete information on "electronically clean air by the roll" see your local AAF representative or write for Rollotron Bulletin 249. Address: Mr. Robert Moore, American Air Filter Company, Inc., 302 Central Avenue, Louisville, Kentucky.

AAF **American Air Filter**

BETTER AIR IS OUR BUSINESS

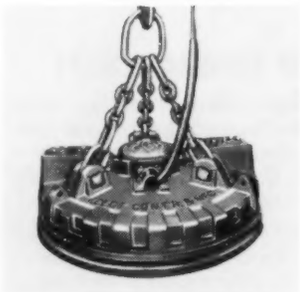
EC&M Lightweight 55" MAGNET

- HANDLES LIGHT SCRAP AT LOWER COST
- WEIGHS UP TO 25% LESS WITH COMPARABLE LIFTING CAPACITY
- FASTER OPERATION OVER WIDER WORKING RADIUS

This magnet, developed by EC&M engineers, is the lightest weight 55-inch magnet. High strength and water-tight construction are maintained with a completely ALL-WELDED design. Elimination of bolt-head recesses allows a better proportion for coil space, giving high lifting capacity. Welding also keeps pole shoes tight.

The companion EC&M lightweight 45-inch magnet has already become popular because its faster maneuverability and greater working radius permit more trips per day. The larger 55-inch magnet incorporates the same profitable advantages. Get the facts...see how these lightweight magnets can cut *your* light scrap handling costs.

Write for Bulletin 1300



The companion EC&M 45"Lightweight Magnet, now in wide use on boom-cranes

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every installation a complete success

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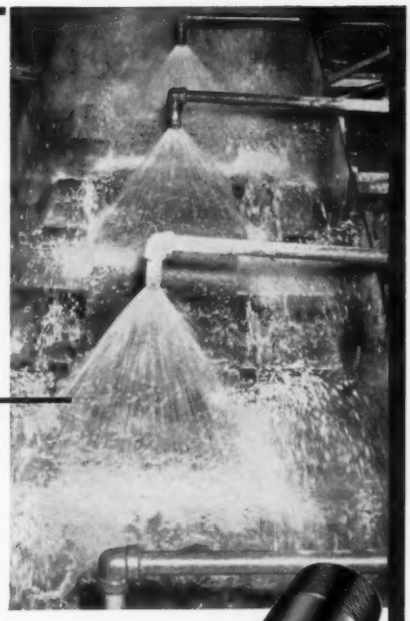

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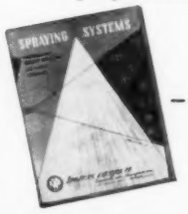
● Greater spraying efficiency and lower equipment and maintenance costs are the advantages Spraying Systems Co. spray nozzles give you. Nozzles for hot strip cooling for example, give better steam barrier penetration and spray distribution . . . remove more heat per minute per gallon of water. Descaling nozzles provide greater impact for any volume and pressure without excessive cooling. Non-clogging design and recommended types of mounting are features that help reduce maintenance costs. Your inquiry is cordially invited for Spraying Systems Co. spray nozzle data and application information.



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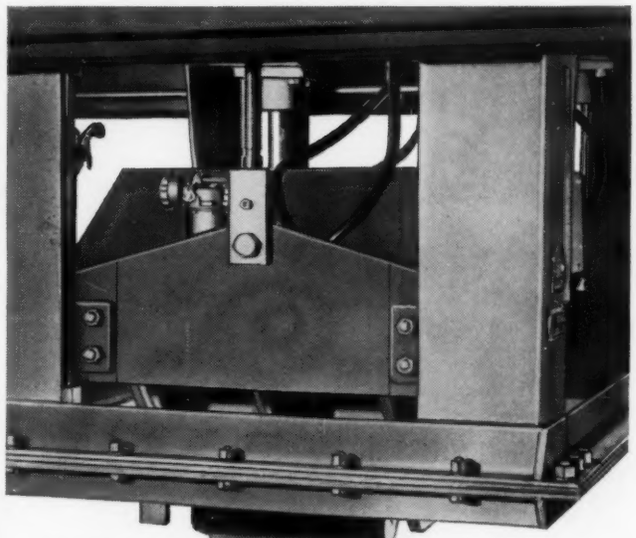
For information on Spray Nozzles and Steel Mill Applications write for Catalog 24 and Supplementary Data Sheets.



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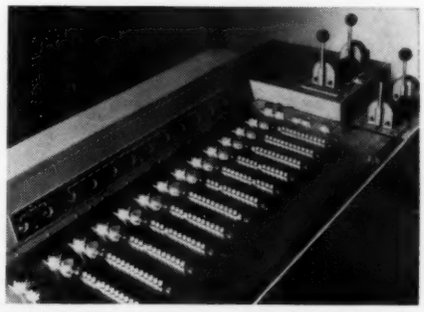
Characters are changed in the marking head and the stamping cycle is actuated from a remotely-positioned operator's console. Among refinements introduced in this latest GY-46 Series: raising and lowering of marking head can clear for 24" bloom . . . keystrips for automatic setup of characters . . . provision for use of printed tapes . . . automatic oiling system . . . provision for setting up by IBM or other punch card system.

On the operator's console a 12-position keystrip may be provided for each of the 12 wheels in the marking head. A press of a button moves any wheel to desired position.



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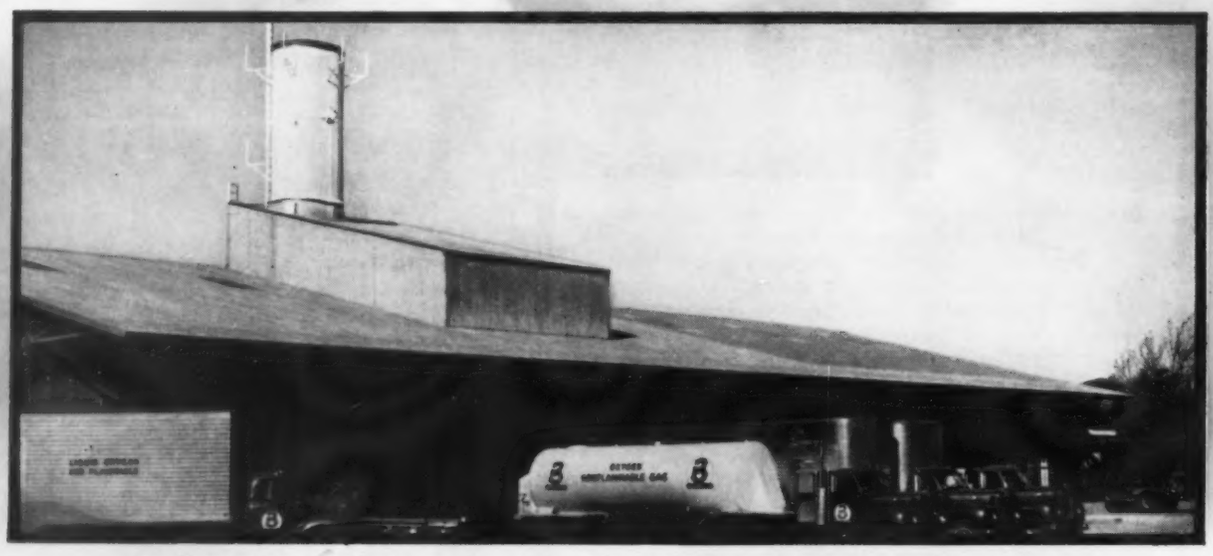
A leading oxygen producer in the Southwest, Big Three, considered very carefully its choice of an engineering firm to design and provide the equipment for a new tonnage plant for the Dallas—Fort Worth area.

That's why they selected Messer for the job!

Messer's long background in this country and abroad has established its reputation as a sound and reliable supplier of air separation plants of all types. In the past two years, Messer has been particularly successful in designing and engineering oxygen-producing equipment of the type Big Three wanted.

HOW IT WORKED OUT

Now that the Messer plant is "on stream" in Fort Worth, what are the results? To quote Mr. C. K. Rickel, Big Three president:



EXCEEDS CAPACITY—Big Three plant at Fort Worth runs above capacity whenever necessary; works efficiently and economically.

Chose MESSER Worth Oxygen Plant

"We are more than pleased with the Messer unit that we installed last summer. It is making its full capacity of oxygen, nitrogen, and argon very efficiently. I would be happy, indeed proud, to show anyone through this plant."

Can *your* business benefit by the installation of tonnage oxygen, nitrogen, or argon producing equipment? If so, be sure to consult American Messer. Your inquiry will be welcomed!

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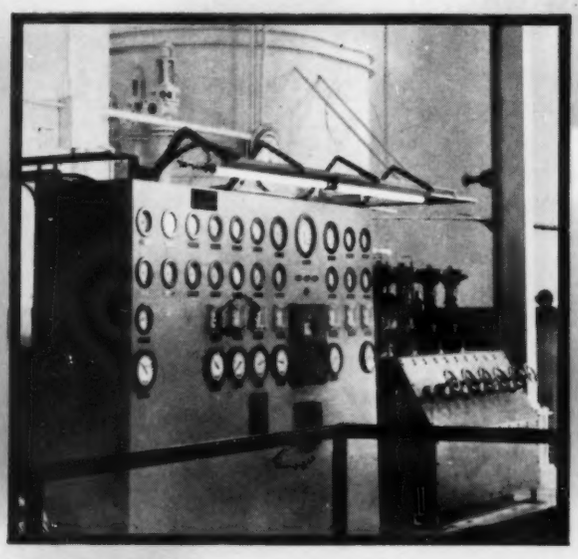
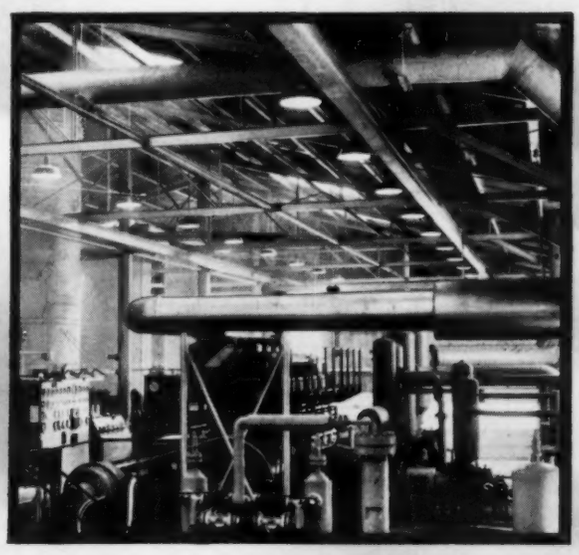
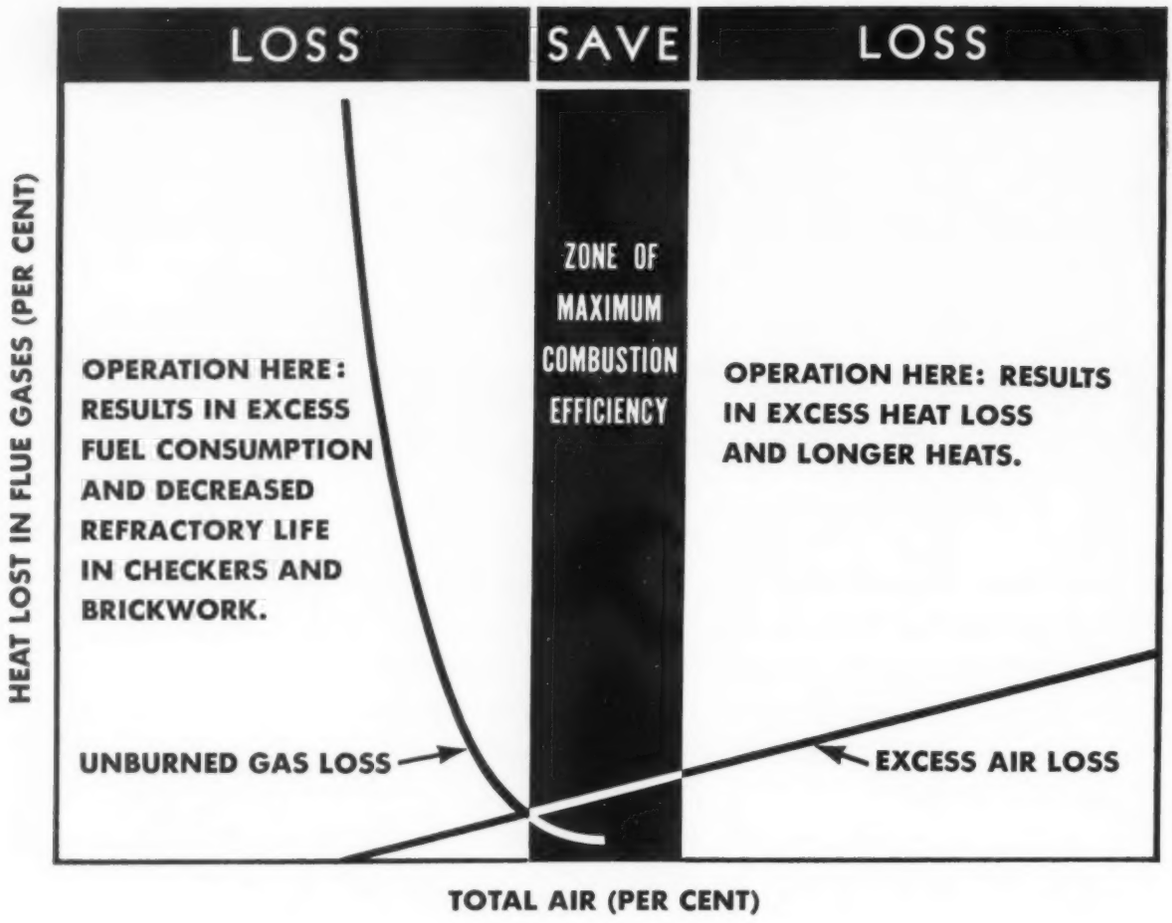


ONE OPERATOR PER SHIFT—Extensive use of automatic controls in Big Three unit requires little attention —only one operator.



REAL POWER ECONOMY—Power for this installation is furnished by an inexpensive natural gas engine—yields products at low cost.

To Save Fuel . . . Analyze for Combustibles, Too . . .


LOSS
SAVE
LOSS
ZONE OF MAXIMUM COMBUSTION EFFICIENCY
OPERATION HERE: RESULTS IN EXCESS FUEL CONSUMPTION AND DECREASED REFRACTORY LIFE IN CHECKERS AND BRICKWORK.
OPERATION HERE: RESULTS IN EXCESS HEAT LOSS AND LONGER HEATS.
UNBURNED GAS LOSS
EXCESS AIR LOSS
HEAT LOST IN FLUE GASES (PER CENT)
TOTAL AIR (PER CENT)

Standard Steel Works finds oxygen and combustibles analysis saves fuel; gives closer control of open hearths.

Results—Fuel conversion was completed without firing difficulties . . . and closer supervision of open hearth operation from a fuel-air ratio standpoint was realized. These were immediate results reported by Standard Steel Works Division of Baldwin-Lima-Hamilton Corporation, Burnham, Pa.

Oxygen and combustibles on same chart

The conversion from oil to oil-natural gas firing was tried first on one of five open hearths. Continuous analysis of combustion gases was added at the same time. The Bailey Analyzer-Recorder played a dual role in training operators, and giving engineers a fast check on the efficiency of the firing system.

Big Help—Part of the credit for success of the changeover goes to the gas analysis system. Here's why—

1. It measures the percentage of oxygen in the flue gas, which indicates the excess air loss.

2. It measures the percentage of combustibles in the flue gas, which is a check on the mixing efficiency of the burners.

3. It provides a continuous and permanent record of both variables on one chart, which, in addition serves as an operator's guide.

Money's Worth—The gas analysis system has been trouble free from the start (July 1957). Operators quickly mastered the technique of oil-gas firing with the help of the analyzer charts. Pleased with the results, Standard Steel Works is installing the same system on its four other open hearths.

Write for Performance Report OH11-1 for complete details on this installation. S12-1

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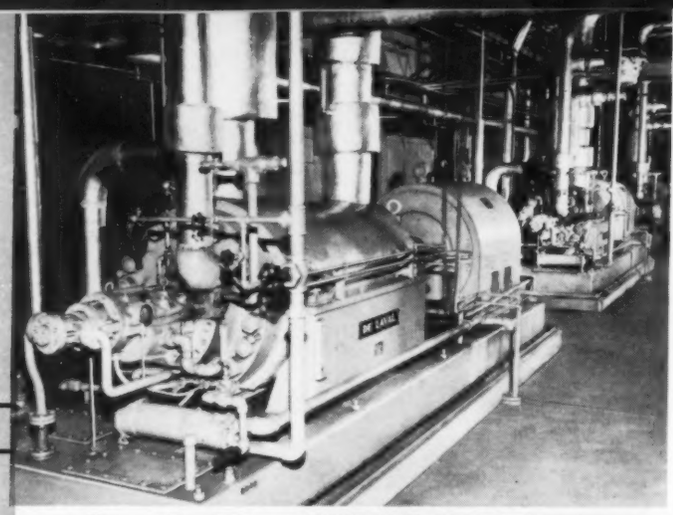

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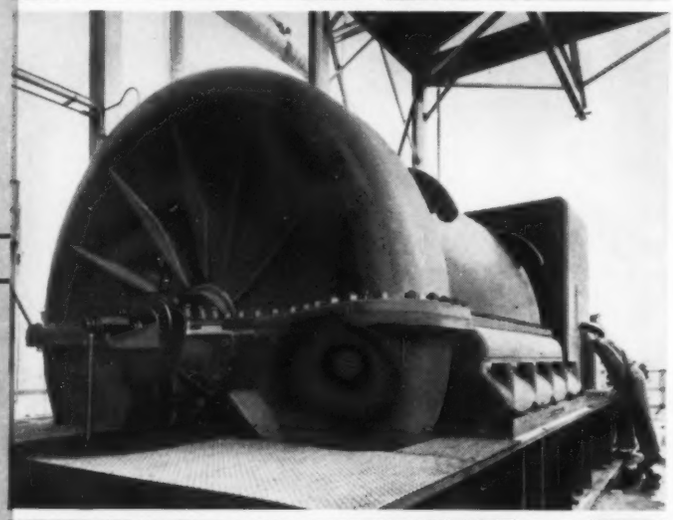

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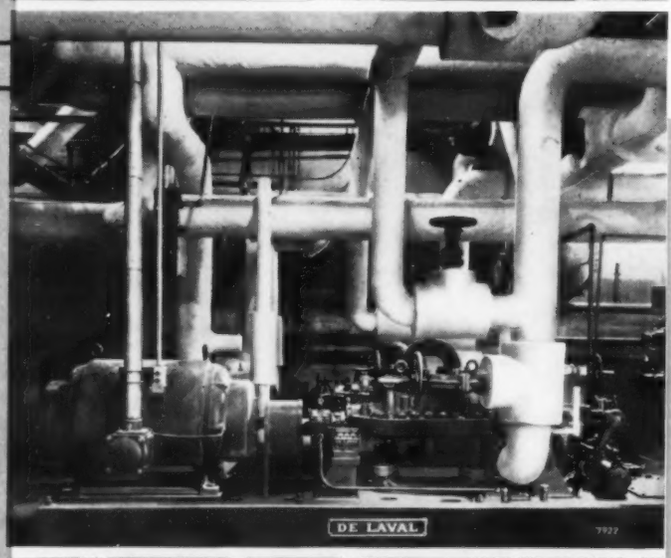

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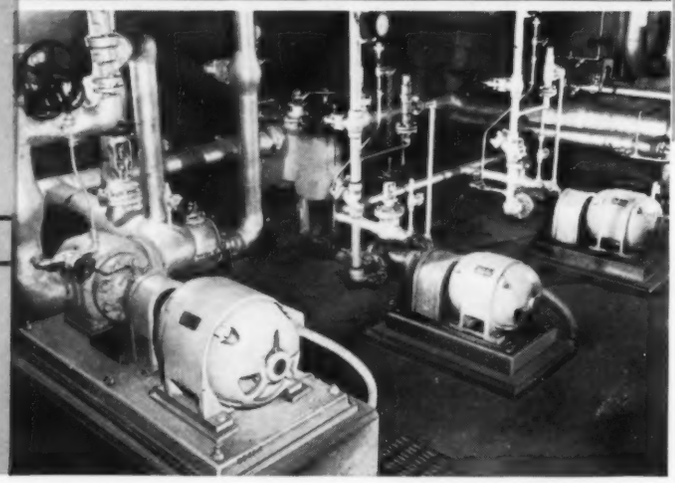

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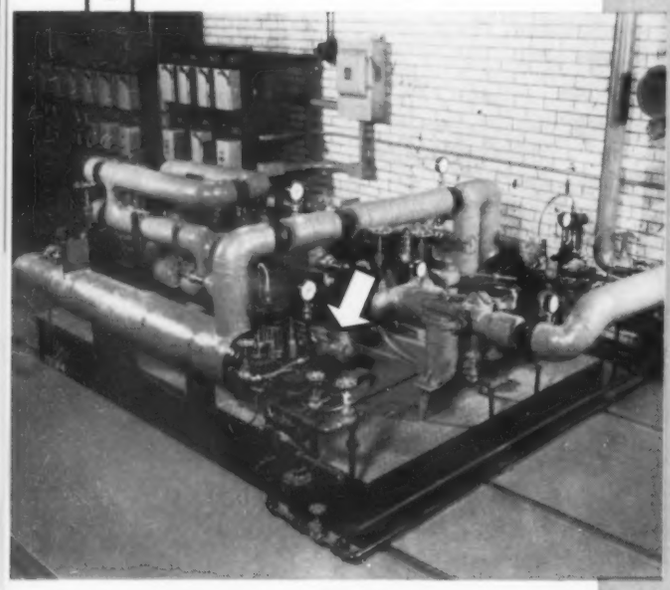

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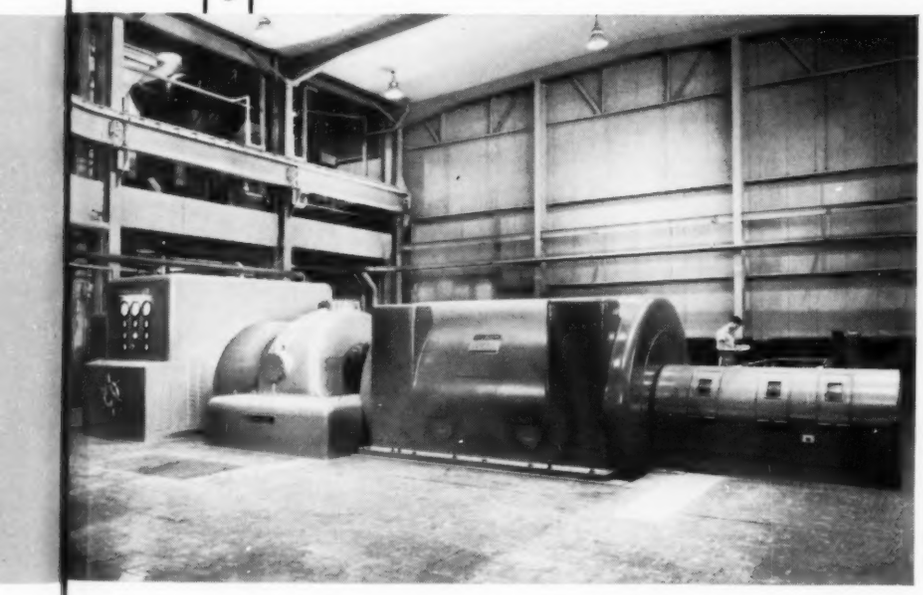

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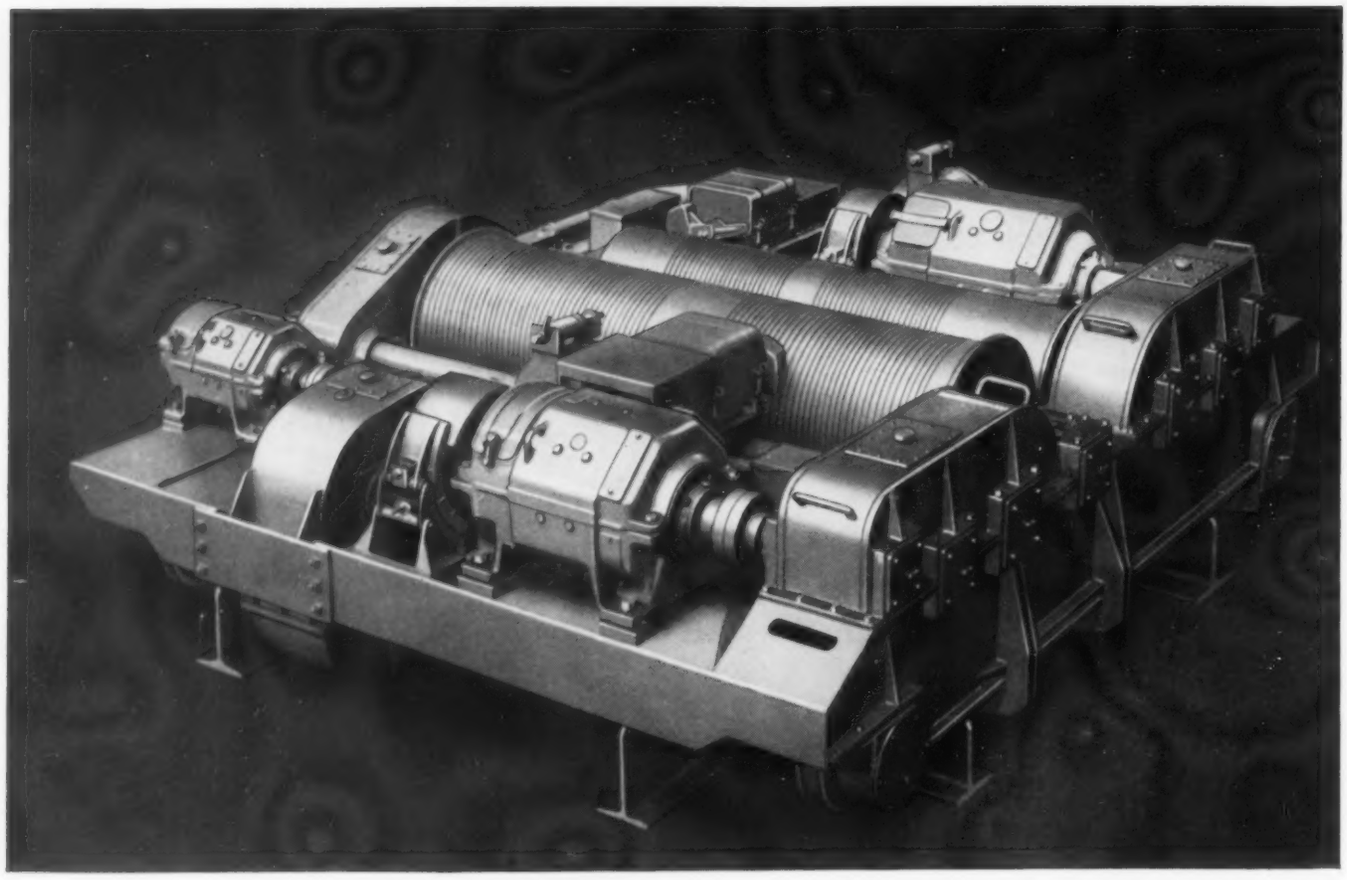

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ALLIS-CHALMERS . . . in step with **STEEL**

Tap sequence changed **from the floor** IN MERE MINUTES **on Allis-Chalmers furnace transformers**

Selectoheat control, an exclusive feature of Allis-Chalmers furnace transformers, slashes downtime from hours to minutes. Convenience is the secret behind this outstanding time conservation. Tap leads are brought directly to a motor-operated tap changer in a separate eye-level, work-level compartment. Gone are the hazards associated with working on top of the transformer. Main tank need only be opened for periodic inspection. With the under-oil terminal boards eliminated, transformer height has been reduced.

Call your A-C man for details, or write Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wisconsin.

ALLIS-CHALMERS

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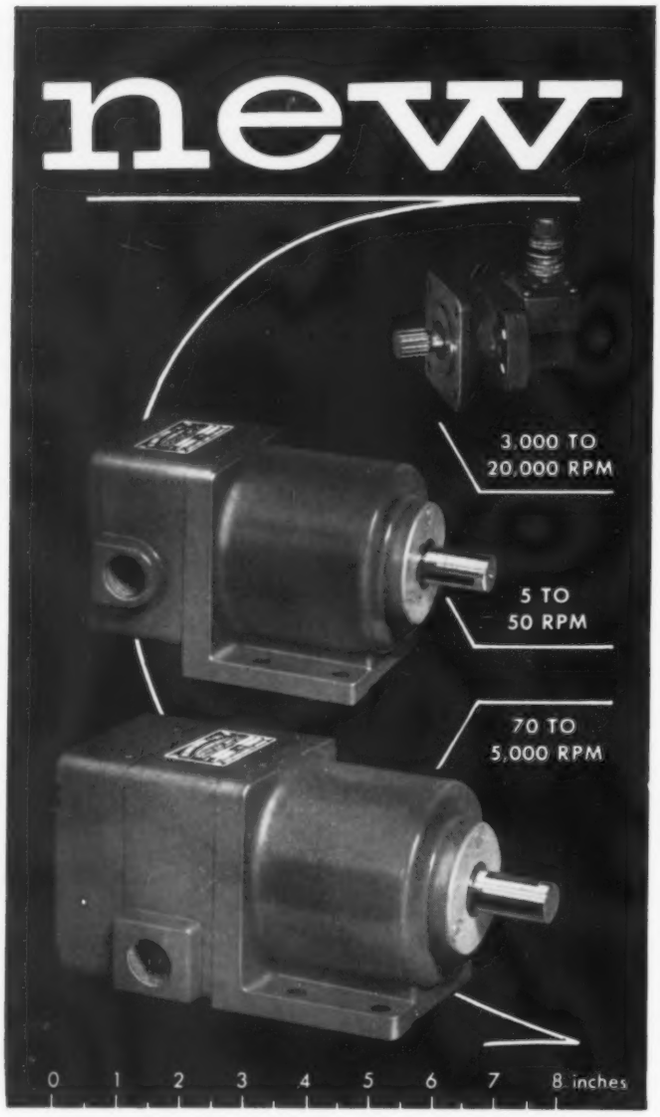

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These control-circuit switches, depending on the type, are responsive to changes in speed from 1¼ to 20,000 rpm and direction of rotation. Contact adjustment may be made while running. Rugged construction, several contact arrangements and consistent accuracy make them suitable for applications such as zero-speed or plugging switches on machine tools, as over-speed or under-speed switches on rotating machines and drives of all types, as anti-plugging switches on machinery with inertia loads and as interlocking switches for conveyor systems. Ask for descriptive Bulletins 2210, 2220 and 2230.

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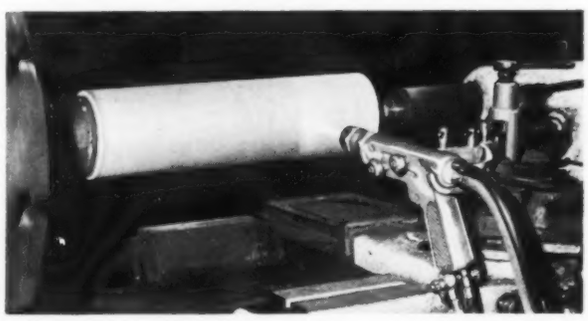
SPRAYWELD® Hard Surfacing Cuts Journal Costs

Table roller journal sleeve maintenance costs were cut from $21.06 to only $1.50 each per month through the use of the Colmonoy Spraywelder (reports the September 1957 issue of *Iron and Steel Engineer*). The Spraywelder, a universally accepted powder metal spraying unit, applies Colmonoy hard-surfacing alloys to provide low-cost protection against abrasion, impact, heat, and corrosion.

The Colmonoy Spraywelder sprays powdered Colmonoy alloys to form smooth, even overlays. The overlays are then fused to the part, forming an integral surface of wear-resistant alloy. Write now for complete information about this versatile maintenance tool.



Journal sleeves are made of low carbon seamless steel tubing, with an overlay of Colmonoy No. 6 hard-surfacing alloy, applied by the Spraywelder. The sleeve is rotated in a lathe, with the Spraywelder mounted in a tool-post holder.

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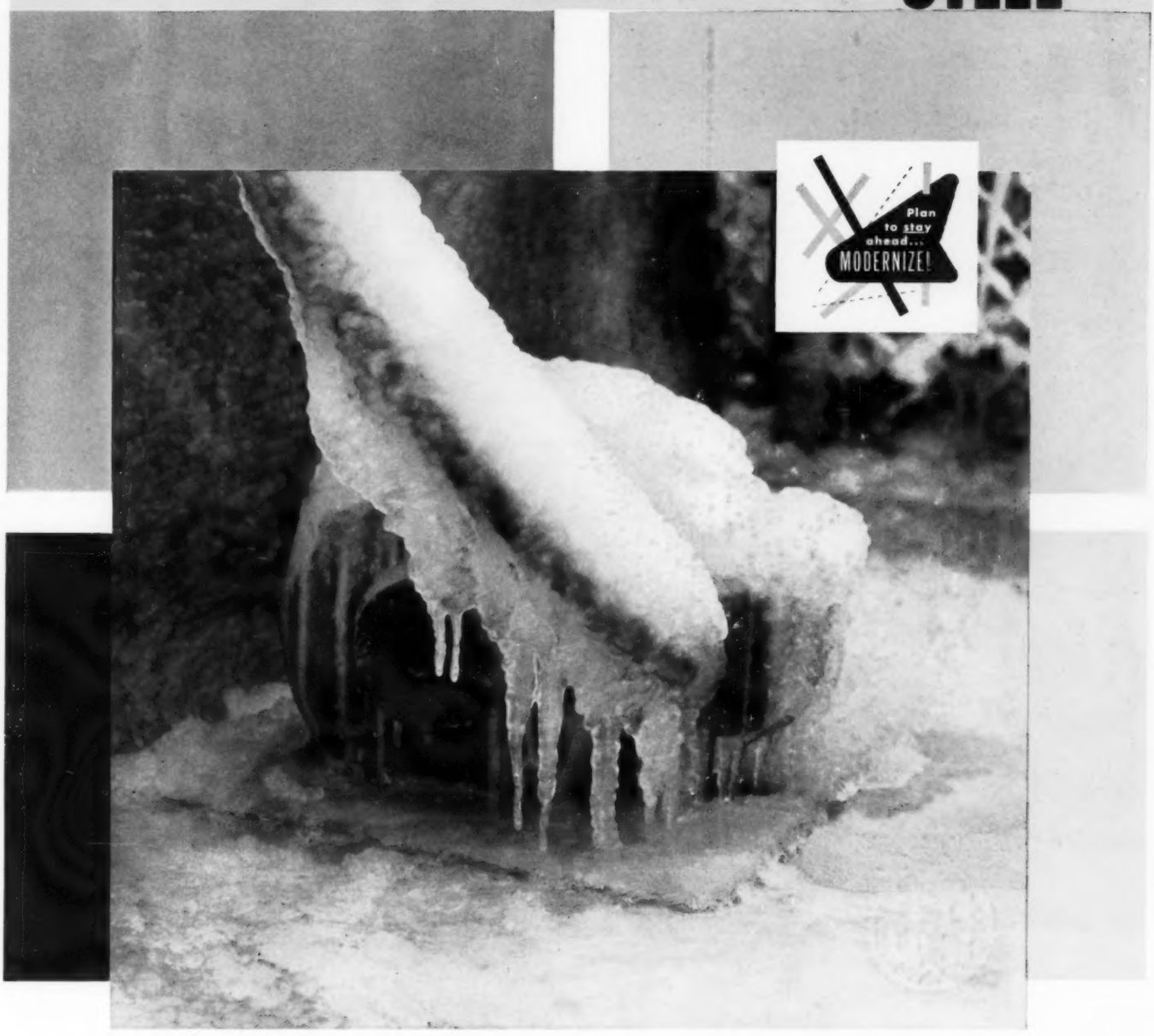
ALLIS-CHALMERS MOTORS in step with STEEL



Allis-Chalmers tackled this motor problem "cold"

Even heavy icing couldn't freeze this motor. An Allis-Chalmers customer required that this open-type *Super-Seal* motor with *Poxeal* insulation start even though embedded in ice.

The successful tests were conducted in the A-C Motor Laboratories where customers' motor needs point the way to continuous development programs.

Research, combined with testing of this type, has established Allis-Chalmers as a pioneer-leader in the motor industry. It has led to the most complete line of integral-horsepower motors; it has led to tremendous acceptance of such A-C developments as *Synduction* and tube-type motors, and now *Super-Seal* motors.

Motor buyers in the iron and steel industry can benefit from this pioneer-leadership by contacting their A-C representative or distributor, or writing Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin.

ALLIS-CHALMERS AC

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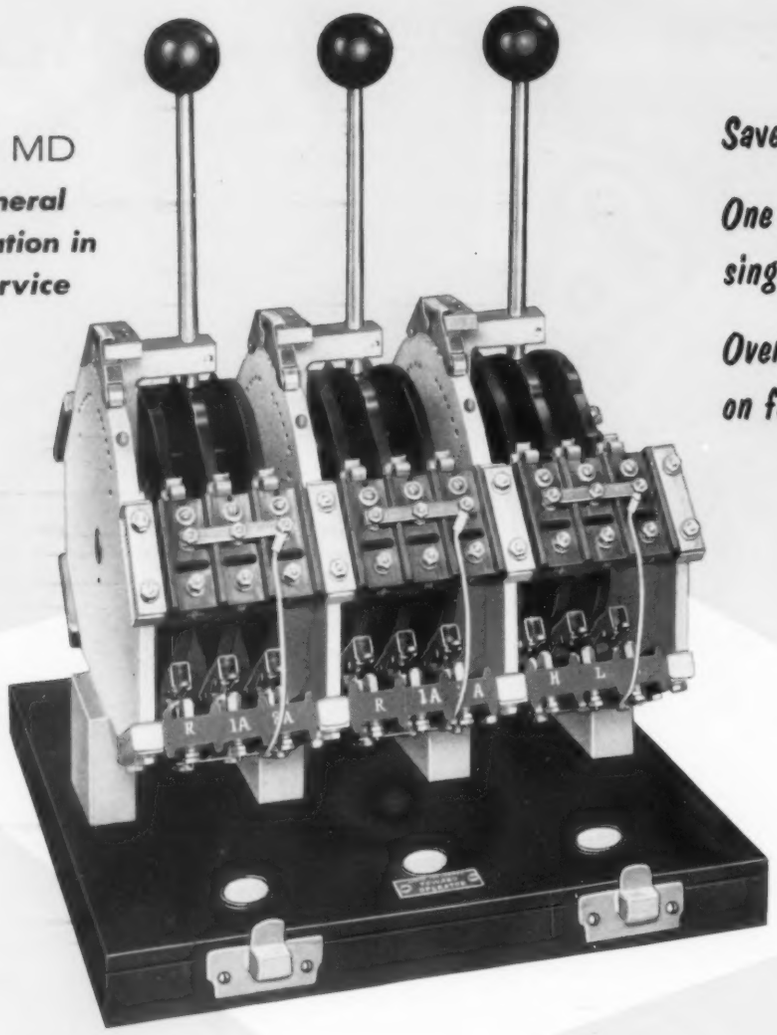
A-5956-1S

Type MD

for general application in Mill Service



Save valuable mounting space

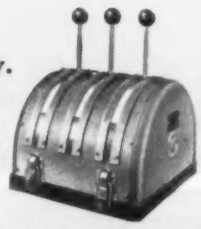
One to four switches in a single enclosure

Overall length less than 22" on four unit switch

P-G master switches

Unique in design, the Post-Glover Type MD Master Switch saves valuable mounting space in crowded crane cabs or mill pulpits where sufficient room has always been a problem. Each single Master has a maximum of 12 circuits and up to 6 points either direction.

The operating lever has exceptionally short angular travel and can easily be adjusted in length, thus adding to operator comfort and efficiency.



Enclosure easily removed.

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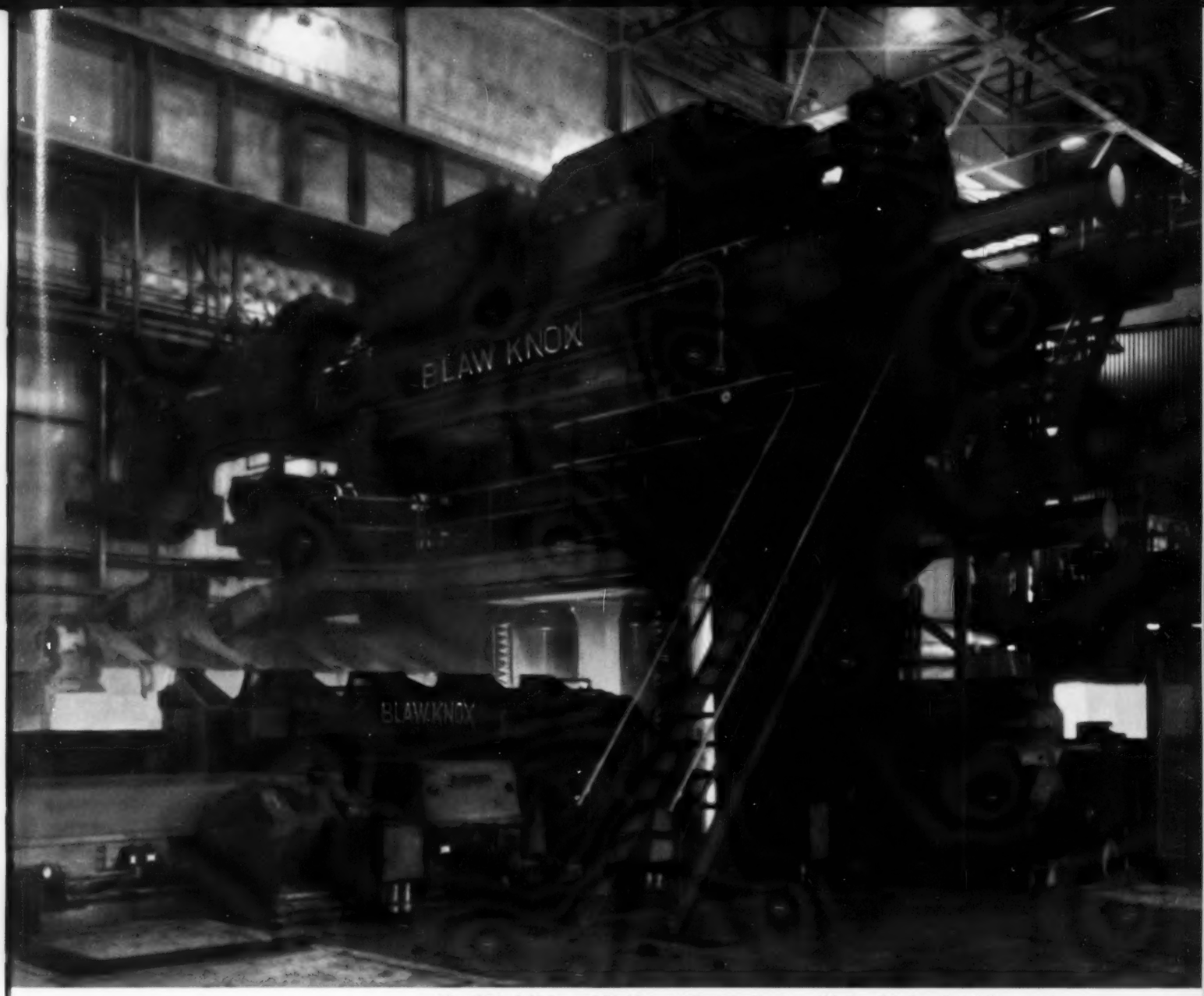

46 x 90 inch Universal Slabbing Mill at the Fontana Works of Kaiser Steel Corporation.

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Blaw-Knox designs and builds slabbing-blooming mills in a complete range of sizes in universal and high lift types. Other Blaw-Knox equipment for the metals industry includes complete rolling mill installations and auxiliary equipment for ferrous and non-ferrous metals, iron, alloy iron and steel rolls, Blaw-Knox Medart cold finishing equipment, carbon and alloy steel castings, fabricated steel plate or composite design weldments, steel plant equipment, and heat and corrosion resisting alloy castings.

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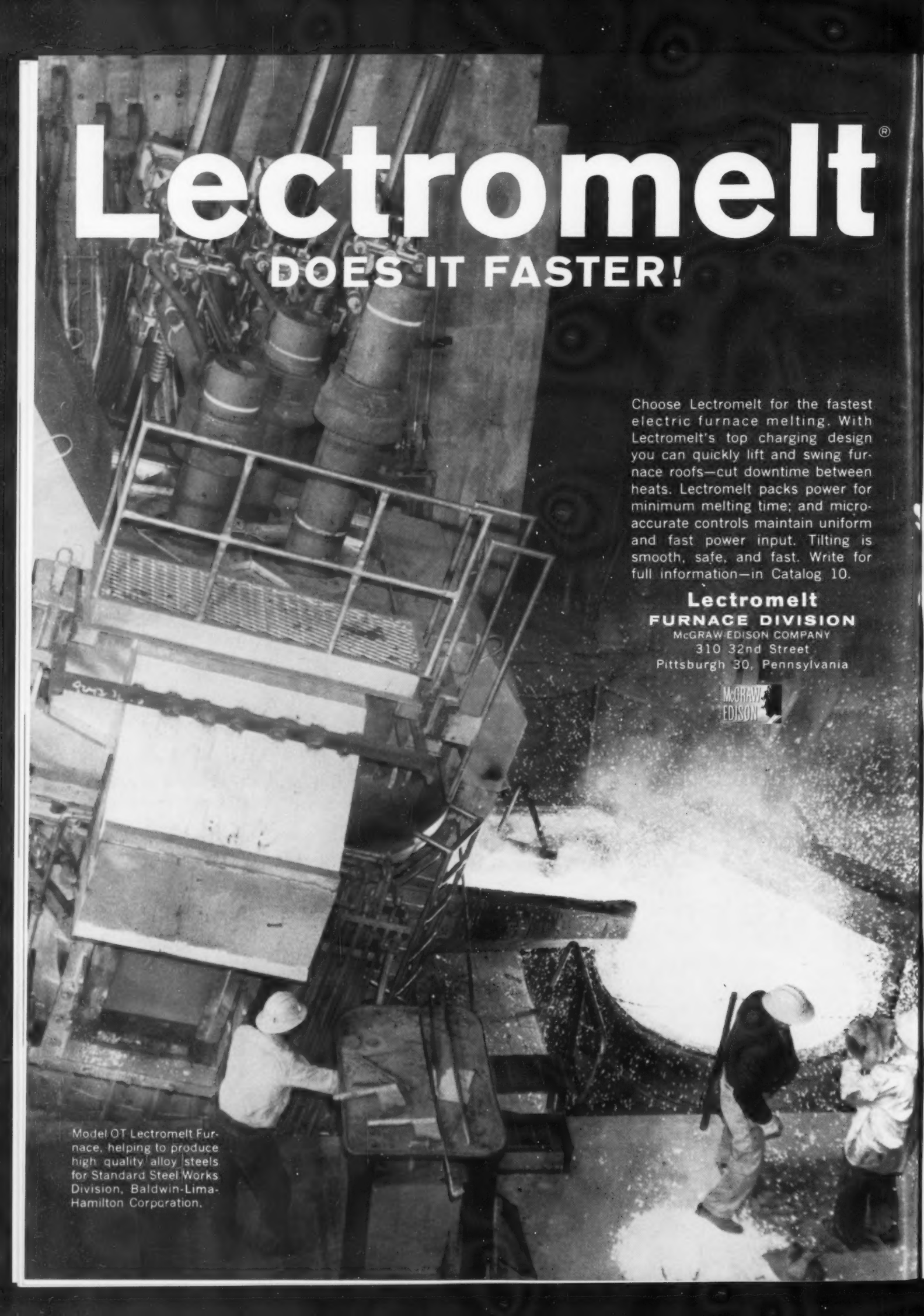
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Choose Lectromelt for the fastest electric furnace melting. With Lectromelt's top charging design you can quickly lift and swing furnace roofs—cut downtime between heats. Lectromelt packs power for minimum melting time; and micro-accurate controls maintain uniform and fast power input. Tilting is smooth, safe, and fast. Write for full information—in Catalog 10.
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Model OT Lectromelt Furnace, helping to produce high quality alloy steels for Standard Steel Works Division, Baldwin-Lima-Hamilton Corporation.

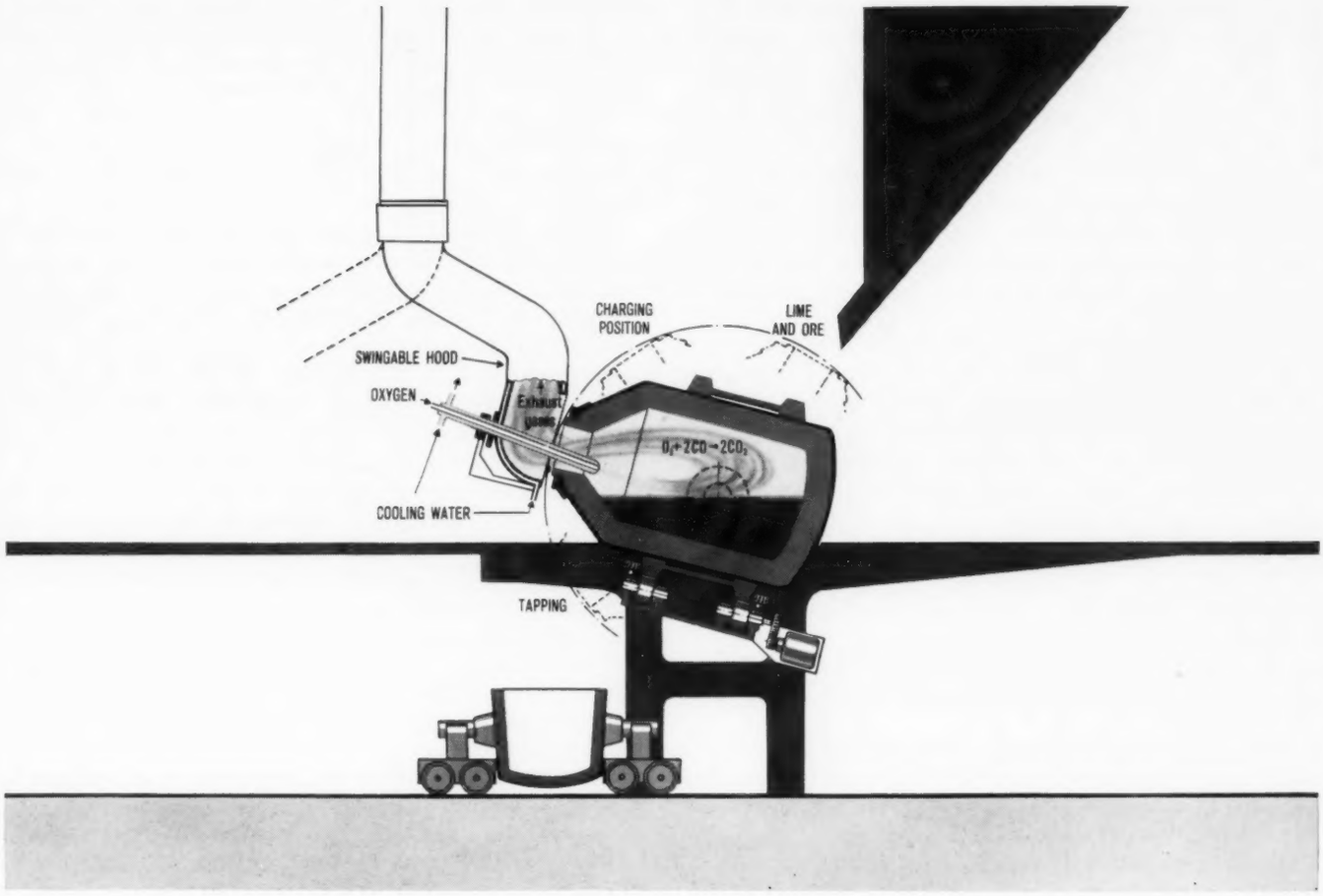


Figure 1 — Sketch shows 30-ton rotating converters. Unit has an outside diameter of about 11½ ft and is about 18 ft long.

The Kaldo Oxygen Steelmaking Process— its metallurgy and economics

by T. Olaf Dormsjo, Stora Kopparberg Corp., New York, N. Y.
and D. R. Berg, Dravo Corp., Pittsburgh, Pa.

A new steelmaking process looms across the horizon . . . . making use of a specially designed top-blown converter vessel, the process includes rotation of the vessel, giving flexible control advantages.

PART I

THIS paper covers up-to-date information on the Kaldo oxygen steelmaking process from the standpoint of metallurgy and economics. Much has been learned since 1956 when Stora Kopparsbergs Bergslags A.B. started refining basic bessemer pig iron with the process at Domnarvet, Sweden, on a commercial basis.

With a furnace having a capacity of 25 to 30 tons of pig iron, experience has provided valuable "know-how" of practical operation, evaluation of quality and reasonably accurate projections of production costs on larger equipment.

The initial phase of this paper will deal with metallurgical experiences, while the second phase will deal with the economics.

Although there are large deposits of high-grade low phosphorous iron ore in Sweden, it is to the advantage of the Swedish national economy to sell this material in foreign countries and utilize in the domestic steel industry the high phosphorous content ore, of which there are also large deposits.

In order to refine pig iron made from the high phosphorous ore in high-production, low capital cost plants, oxygen-blown rotating furnace was developed at Domnarvet. Its operation has proved to be commercially successful and it also has proved to have broad metallurgical flexibility.

Not only does the process solve problems in the refining of Sweden's high phosphorous ores, but it has proved adaptable for the conversion of low phosphorous iron. It makes possible the economic production of high quality steels which are low in sulphur, phosphorous and nitrogen content. It also can produce high-quality carbon steels without recarburizing.

The furnace, shown in Figure 1, consists of a rotating vessel with two running rings. This is mounted on four supporting wheels in a heavy cradle, which can be turned on trunnions.

The vessel has an outside diameter of 11½ ft and is about 18 ft long. The inside diameter (lined) is about 7½ ft.

The oxygen is introduced through a water-cooled lance in the exhaust hood. The gas is blown against the surface of the bath at a flat angle which can be varied, as can the position of the end of the lance.

The lance is inserted into the furnace about three feet, and the oxygen pressure is approximately 44 psi after the control valve. Maintenance costs of the lance, and the water-jacketed exhaust hood are negligible.

The furnace is inclined at the 17-degree angle during the blow so that the melt will cover at least half of the back wall. With this arrangement the back wall lining as well as that on the cylindrical walls is in contact with the bath during the rotation of the furnace. This practice avoids overheating of the lining when carbon monoxide is burned to carbon dioxide by the oxygen above the bath. This angle of inclination also increases the productive capacity of the furnace.

D-c motors control the speed of rotation from zero up to 30 rpm. The ability to change the speed of the vessel is important to the production process as a control of the iron content of the slag, and the general run of the heat. For example, when the vessel is in rapid rotation the content of iron oxides becomes low and the slag comparatively viscous or dry. A decrease in speed has the opposite reaction.

In refining basic bessemer iron, it has been found desirable to bring the carbon content down to between one and two per cent before most of the phosphorus is oxidized. To do this the vessel is rotated at full speed during this part of the blow to delay the slag melting. The speed is then reduced to raise the iron content of the slag for effective dephosphorization, and finally is increased near the end of the blow to obtain a low iron oxide content in the slag, and a low oxygen content in the steel.

The temperature in the exhaust gas pipe is an excellent indicator of how the reactions in the vessel are proceeding. Because the carbon gives off gaseous reaction products, the exhaust temperature will indicate whether the carbon or other elements are being oxidized.

Temperature also indicates the intensity of the boil. A strong boil forms more carbon monoxide with the addition of a constant quantity of oxygen. This carbon monoxide then burns in the exhaust gas hood, creating a higher temperature in the gas flue. A decrease in rotation velocity slows down the boil, the carbon monoxide is consumed more thoroughly inside the furnace and the temperature of the gases going out the stack is reduced. It is, therefore, easy to determine the temperature of the exhaust gases that will correspond to a sufficiently complete combustion of the carbon monoxide in the furnace, and to control this combustion during the boil by altering the speed of furnace rotation.

The Domnarvet plant has two vessels to assure a continuous operation. An overhead crane is employed for the charging of pig iron and scrap. Lime and ore or sinter are added by means of a chute connected to storage bins. Economic conditions in Sweden dictate the predominant use of sinter fines instead of scrap as the addition at Domnarvet. The crane is also used for the removal of a vessel from the operating position for relining.

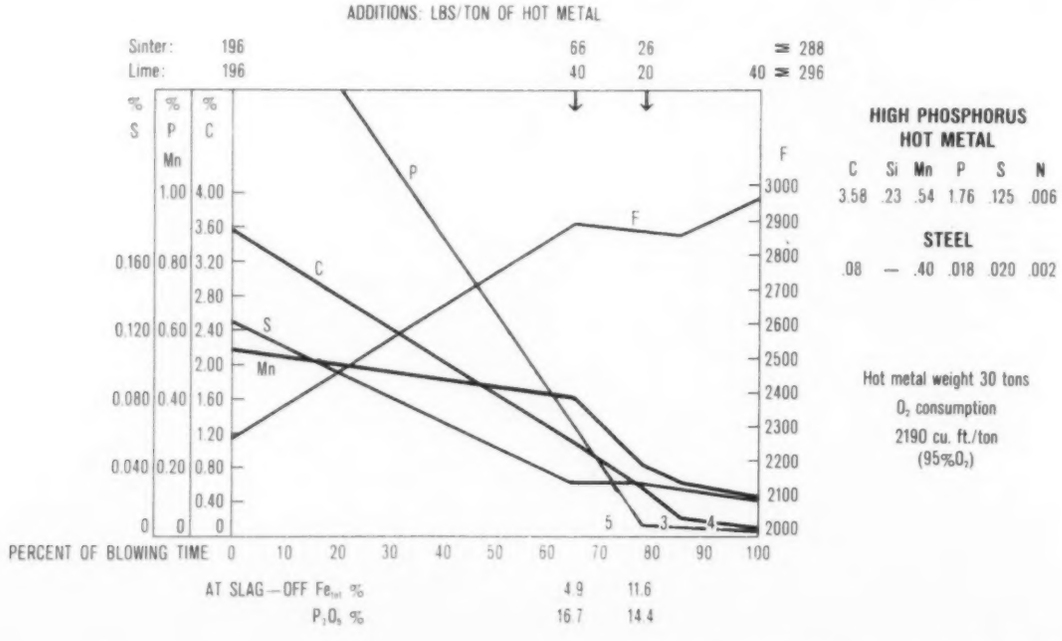


Figure 2 — Chart shows steps in refining basic bessemer pig iron to low carbon steel which is the normal one in operation at Domnarvet.

TABLE I

Heat No. R3922—30 Tons of High Phosphorous Hot Metal—Low Carbon Steel

Operation	Time, per cent of total		Additions, lb		Oxygen, cu ft (70 F, 760 mm)	Steel temperature, F	Analysis, percentage					Fe in Slag
							Metal					
	Blowing	Non-blowing	Sinter	Lime			C	Si	Mn	P	S	
Charging	...	28.5	6900	6060	...	...	3.63	0.37	0.75	1.93	0.059	...
Blowing	38	...	...	...	23,900	...	...	...	...	...	...	...
Charging	...	11	2180	2200	...	...	...	...	...	...	...	...
Blowing	54	...	...	...	29,600	...	...	...	...	...	...	...
Slag-tapping and sampling	...	20	...	...	...	2875	0.18	...	0.19	0.048	0.029	7.5
Charging	. .	6	...	550	...	...	...	...	...	...	...	...
Blowing	8	...	...	...	6,100	...	...	...	...	...	...	...
Sampling and preparing	...	28.5	...	...	...	2950	0.06	...	0.08	0.024	0.022	20.0
Tapping	...	6	...	...	...	...	...	...	...	...	...	...
Total	100	100	9090	8810	59,600	...	0.12	...	0.94	0.031	0.019	...
Lb per ton of hot metal	...	...	300	290	...							
Cu ft per ton of hot metal	...	...	...	...	1,970							

HEAT CYCLE WHEN REFINING BASIC BESSEMER PIG IRON

At Domnarvet the Kaldo process is used for refining basic bessemer pig iron normally containing about 1.8 per cent P. The cycle is shown on Figure 2.

In this case the main part of the phosphorus is oxidized at a time when the steel contains 1.5 per cent C. The heat surplus generated during the blow is used for reduction of additional iron ore. The main part of the ore and lime are added before the pig iron is charged, and further additions are made after the phosphate slag has been tapped off.

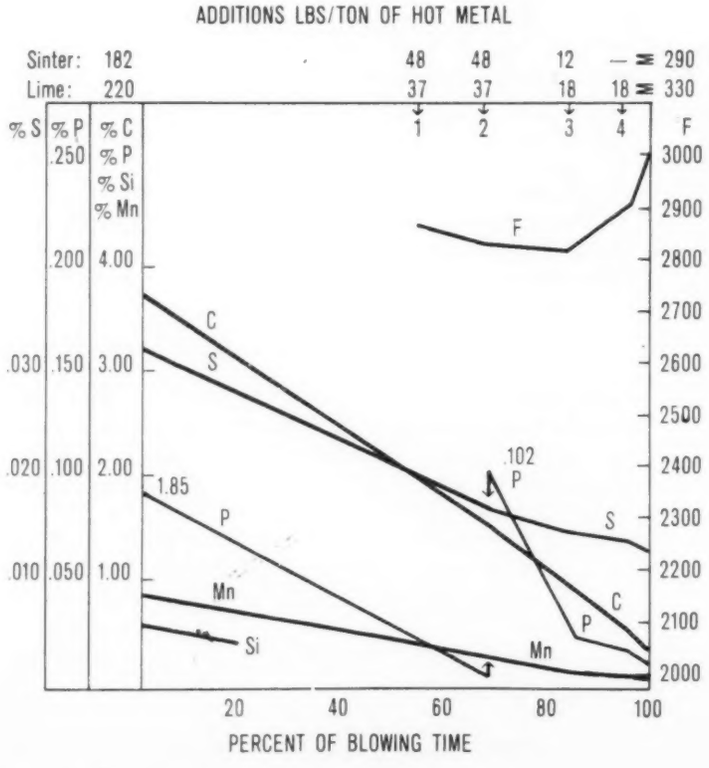
It has been found advantageous to tap off the phosphate slag twice within a short interval. The first tap is made when phosphorus is between 0.2 to 0.3 per cent at which analysis the total iron in the slag is in the range of 3 to 4 per cent. The second tap is made at about one per cent C and less than 0.1 per cent P.

It is important that the slag be quite fluid, but not foaming, to facilitate tapping; and to reduce the amount of small iron particles suspended in the slag.

The two taps total about 450 lb per ton of pig iron, and contain between 16 and 20 per cent of P_2O_5. This is sold as fertilizer. The final slag is stiffened with lime and is kept in the furnace to be used in the first slag of the next heat.

In addition to the two phosphate slag tappings, there is another stop in the operation for control of temperature and carbon content, when the carbon is 0.10 to 0.20 per cent above the desired value. The tapping temperature and carbon content thus can be controlled within very narrow limits.

When blowing low carbon steel it has been found that time can be saved by delaying the tap of the phosphorous slag until the carbon content has been brought down to 0.20 to 0.30 per cent. The time saved derives from the reduced blowing time and the elimination of one slag-off. After tapping of this slag only a short ad-



MED. CARBON STEEL

HOT METAL

	C	Si	Mn	P	S
	3.70	.33	.90	1.85	.032

STEEL

				Max.	Max.
Spec.	40/45	40/60	40/50	.050	.040
Ingots	.41	.48	.52	.022	.016

Hot metal weight 30 tons

O_2 consumption (95%)

2110 cu. ft./ton

Figure 3 — Chart for refining high phosphorous hot metal to medium carbon steel. Carbon is caught on the way down.

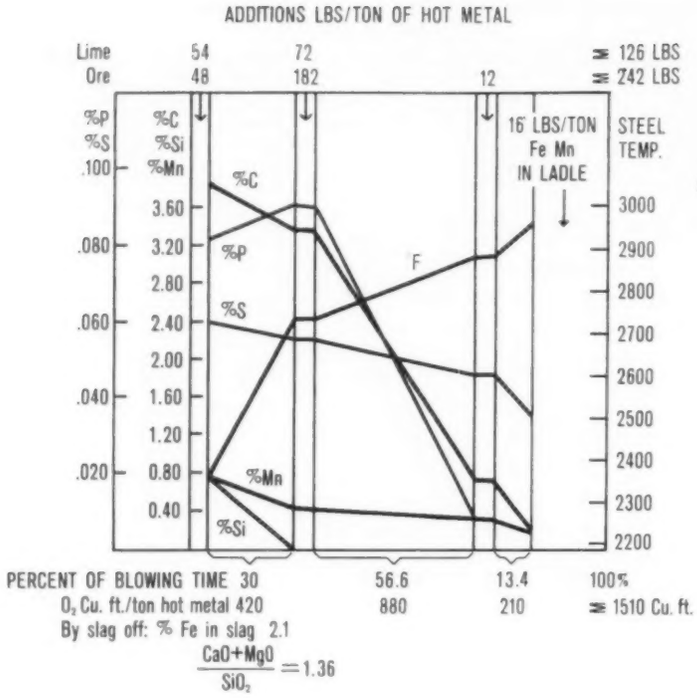


Figure 4 — Log shows refining of low phosphorous hot metal to low carbon steel.

30 TON KALDO HEAT ON LOW PHOSPHORUS IRON

Analyses of:	C	Si	Mn	P	S	N
Hot metal	3.82	0.75	0.76	0.081	0.059	
Ingots	0.15		0.67	0.015	0.028	0.002

ditional blow is required to obtain the desired carbon and phosphorous contents in the final steel. A heat log for this method of blowing is shown in Table I.

Figure 3 shows the blowing of a medium carbon steel from high phosphorous hot metal. No recarburizing was necessary as it is easy to catch the carbon on the way down.

REFINING OF HEMATITE IRON

The process can be used to advantage also for other types of pig iron. A number of heats have been produced successfully, using low-phosphorous iron of ordinary open hearth type. In Figure 4 such a heat is shown.

For this kind of pig iron it has proved advisable at the start to add lime to the hot metal in such quantity that the basicity of the slag $\left(\frac{CaO + MgO}{SiO_2}\right)$ is less than 1.5 after oxidation of most of the silicon. At this basicity a fluid slag with a low Fe content is obtained at 2700 F. Ability of the process to approach closely to equilibrium between steel and slag makes it possible to reduce the Fe content of the slag to 2 to 3 per cent before slag-off.

After the slag is tapped, more lime and ore are added, and the carbon is brought down to the desired content. As shown in the diagram, there is usually one more stop for control of temperature and carbon content before the final blowing.

The first slag is not basic enough to bind phosphorus and sulphur. The diagram shows phosphorus has been picked up in the beginning, because slag was retained from the previous heat which was made from high-phosphorous iron. However, the required dephosphorization and desulphurization can be obtained by adding lime and ore after the silica slag has been tapped off. The slag need not be entirely molten to bind the phosphorus. Final slag containing about 15 per cent Fe is low in volume and part of it is retained in the furnace for the next heat.

Hot metal with an intermediate phosphorous content is blown in the same way as low phosphorous iron. Figure 5 shows such a heat.

Figure 6 shows one of several experimental heats of high carbon steel with a good phosphorous removal.

COOLING ADDITIONS

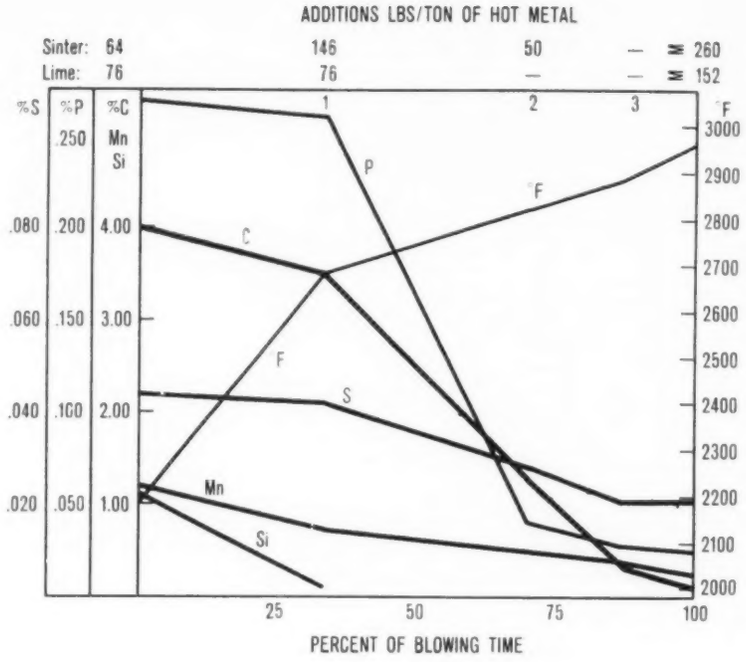
Ore used for cooling need not be of the same high quality as the refining ore used in open hearth and electric steel furnaces. Sinter fines, less than $\frac{3}{4}$ in. in size, containing about 55 per cent Fe and 7.5 per cent SiO_2 are suitable.

Scrap can be used instead of ore, and a number of heats have been made with scrap and a small amount of sinter as a cooling agent to determine the best production procedure. The scrap consisted of heavy return material such as bloom and billet butts, sheet bars, etc., and it was charged in two portions after the hot metal. There was no discernible deterioration of the furnace lining attributable to the scrap—the same lining life was obtained as when using sinter entirely for cooling.

HEAT ECONOMY

An important feature in the process is the burning of most of the carbon monoxide created inside the furnace during refining to carbon dioxide. This increases the total generation of heat by a substantial amount. Rotation of the furnace transports this heat to the bath, making possible large additions of ore, sinter or scrap, resulting in high steel output per ton of pig iron. Part of the oxygen supply is used to burn the carbon monoxide to carbon dioxide. A large amount of extra oxygen is introduced through the use of ore, and the oxygen gas consumption is about the same as the quantity normally used when scrap is employed as the cooling agent.

At Domnarvet, the pig iron normally contains the



MED. PHOSPHORUS

HOT METAL

C	Si	Mn	P	S
4.01	1.13	1.19	.270	.044

STEEL

.06	—	.23	.024	.021

SLAG

	P_2O_5	Fe ox	Fe met	CaO	MgO
1.	.70	2.9	.4	43.3	6.8
3.	4.10	10.9	4.3	46.9	5.6

	SiO_2	S
1.	34.1	.137
3.	17.4	.170

O_2 consumption (95%)
1845 cu. ft./ton

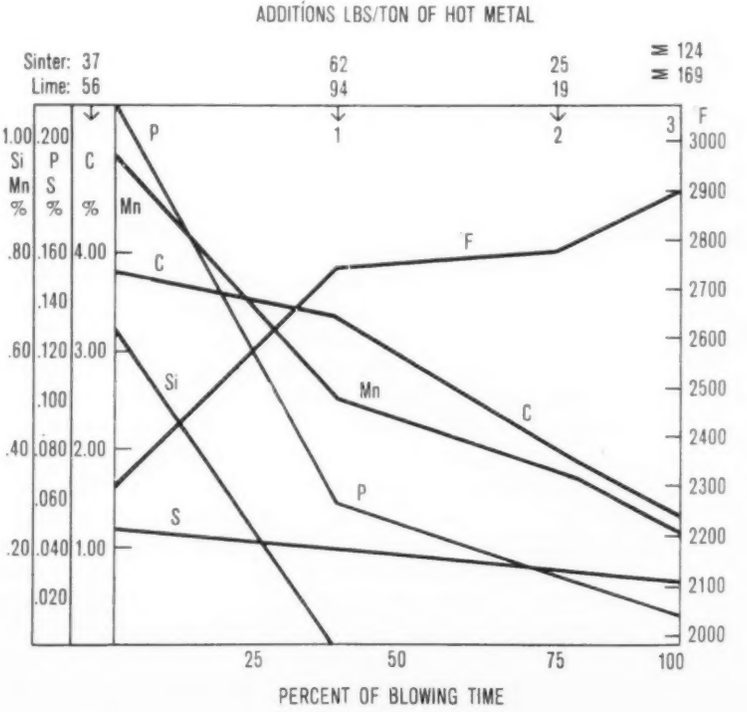
Figure 5 — Log shows refining of medium phosphorous hot metal to low carbon steel.

following percentages: 3.6 C, 0.3 Si, 0.7 Mn, 1.85 P, 0.06 S, and 0.25 V. In addition to about 290 lbs of lime per ton of pig iron used for the formation of slag, about 300 lb of 55 per cent Fe ore are added during the blow. Reduction of this ore increases the output of steel by about 160 lb for each ton of pig iron.

When refining a low phosphorous pig iron containing about 4 per cent C and 1 per cent Si, at least the same quantity of ore can be added. The consumption of oxygen per ton of ingot is in both cases about 2070 cu ft. When using scrap instead of ore it has been found possible to add about 1100 lb per ton of pig iron.

These results are obtained when burning an average of about 75 per cent of the carbon monoxide inside the furnace. With the more complete combustion of the carbon monoxide in a larger furnace, it can be calculated that approximately 40 per cent scrap of the total metallic charge can be melted, depending upon the characteristics of the hot metal and the specification for the blown metal.

The influence of the conversion of carbon monoxide to carbon dioxide in the heat economy is illustrated in Figure 7. When using a pig iron low in phosphorus, the heat created at a complete combustion of CO to CO_2 represents, as shown, more than half the total amount of heat generated by oxidation. Also shown on this chart is the amount of scrap, as a per cent of total metallics charged. that can be melted as a function of the degree of CO-CO_2 conversion inside the furnace, when blowing an average composition pig iron to a low carbon (0.089) steel.



HIGH CARBON STEEL

HOT METAL

C	Si	Mn	P	S
3.78	.65	.99	.222	.048

STEEL

1.30	—	.23	.012	.026

SLAG

	P_2O_5	Fe ox	Fe met	CaO	MgO	SiO_2
1.	4.2	9.3	.2	44.6	4.1	21.8
2.	3.0	13.5	2.4	51.0	5.1	13.9
3.	2.6	19.3	1.0	48.2	5.1	12.2

Hot metal weight 29.5 tons
O_2 Consumption (95%)
1265 cu. ft./ton

Figure 6 — Log shows refining of low phosphorous hot metal to high carbon steel.

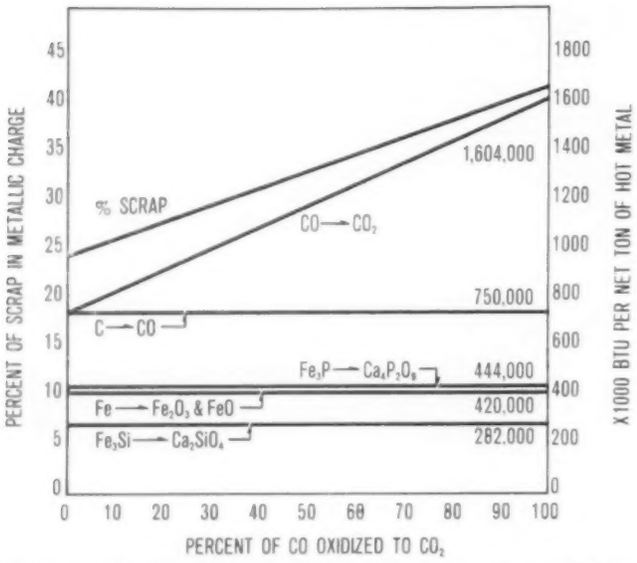
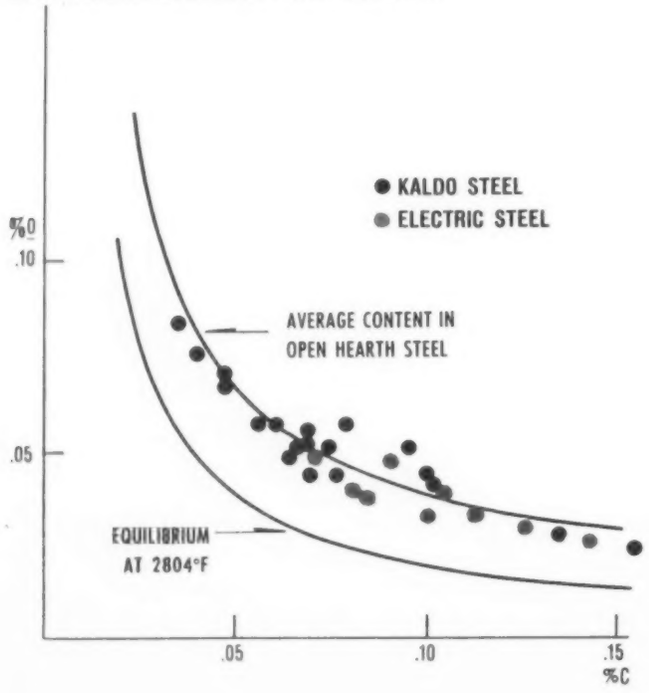


Figure 7 — The conversion of carbon monoxide to carbon dioxide results in good heat economy.

TABLE II
Steel Yield

	Basic bessemer	Kaldo high P
Charged:		
Hot metal	1000	1000
Scrap	100	...
Iron from ore	11	82
Additions	11	10
Total	1122	1092
Obtained:		
First-rate ingots	954	978
Scrap	58	24
Fe in slag and exhaust gases	45	25
Oxidation of alloying elements	65	65
Total	1122	1092
Ingot yield, per cent	85.0	89.6

Figure 8 — Curves give oxygen content in converter steel and electric steel before the oxidation.



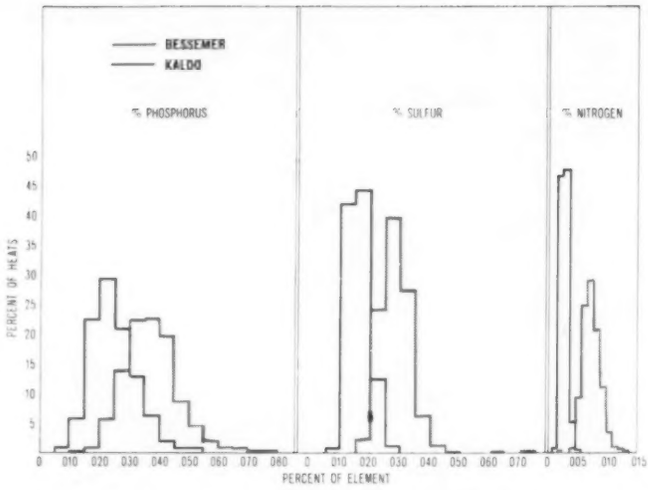


Figure 9 — Relative distribution of phosphorus, sulphur and nitrogen in rotating converter and basic bessemer steels for low carbon rimmed specifications.

A complete material and heat balance for the Kaldo process when refining basic bessemer pig iron at Domnarvet is shown in Appendix I.

STEEL YIELD

A high yield is obtained in the process. This results from low iron loss in exhaust gases and slag and the absence of foaming slags. The exact yield achieved will depend upon pig iron and blown metal composition as well as composition of the charge. See Table II.

GAS CLEANING

Gas volume is low because carbon monoxide is burned to carbon dioxide inside the furnace, making unnecessary the inspiration of large amounts of air at the entrance to the exhaust head. At Domnarvet iron loss in the gas is 0.5 per cent or 10 lb per ton of ingot.

STEEL QUALITY

Control of the content of impurities—oxygen, phosphorus, nitrogen, and sulphur—and tapping temperature is important to the quality of the steel.

The oxygen content is determined by the carbon-oxygen equilibrium. In this respect the process is similar to the open hearth but differs from the basic bessemer.

Tests taken immediately after the end of the blow, at carbon contents in the range 0.04 to 0.12 per cent, have given values of the product (C) × (O) varying between 0.0025 and 0.0040. This is in the same range as that for open hearth steel, as shown in Figure 8.

With the vessel in rotation and with oxygen off, it is possible to get even closer to the equilibrium value.

In making semi-killed steels it has been easy to arrive at the desired deoxidation pattern, using the same amount of ladle additions from one heat to another. This indicates a uniformity in the degree of oxidation of the steel after final blow, and, consequently, a favorable starting point for the final deoxidation, which is the main factor in determining the ultimate oxygen content in the steel.

In low carbon rimming steel for deep drawing pur-

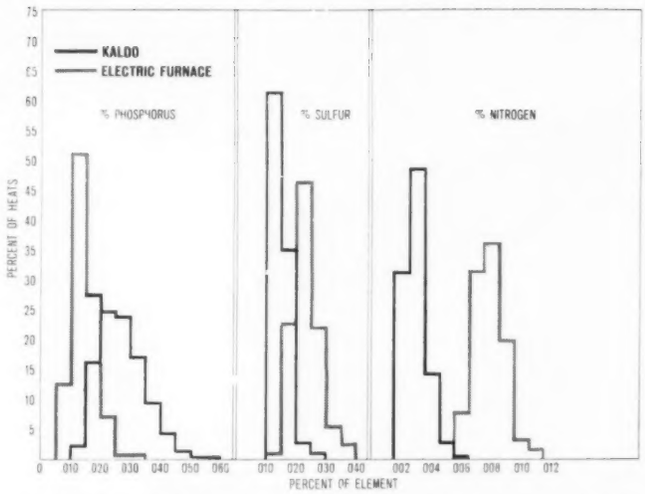


Figure 10 — Relative distribution of phosphorus, sulphur and nitrogen in rotating converter and electric furnace steels for semi-killed specifications.

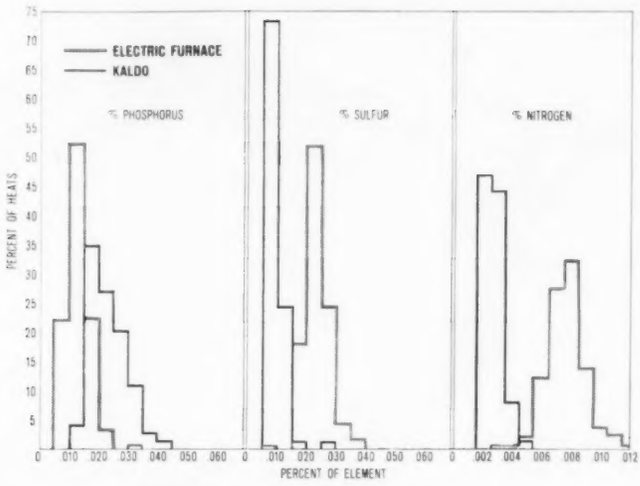


Figure 11 — Relative distribution of phosphorus, sulphur and nitrogen in rotating converter and electric furnace steels for rimmed specifications.

poses, the phosphorous content can easily be kept at 0.020 per cent. Even specifications with a maximum of 0.015 per cent P have been successfully produced when using normal basic high phosphorous bessemer iron. For high carbon killed steel it may be necessary to work with somewhat higher phosphorous contents, but specifications of maximum 0.030 to 0.035 at 1.8 per cent P in the pig iron can be reached without any difficulties.

The nitrogen content of the steel generally varies between 0.002 and 0.003 per cent by using an oxygen gas with 95 to 96 per cent O_2. When using oxygen above 99 per cent there is no difficulty in obtaining 0.001 per cent N_2 in the molten steel before deoxidation. The difference between these figures and those in open hearth steel, usually amounting to 0.004 to 0.005 per cent, is of importance for ductility. In the production of so-called

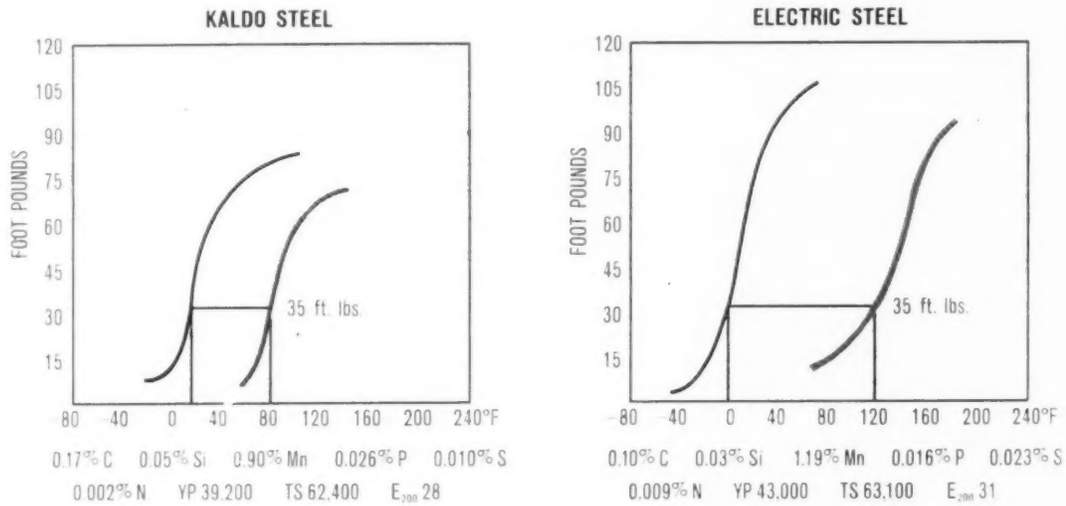


Figure 12 — Curves give impact strength (Charpy v-notch) on 1-in. plate (top of ingots) for normalized steel (solid lines). Dotted lines give same data for normalized and aged (10 per cent strained + 482 F, 1 hr).

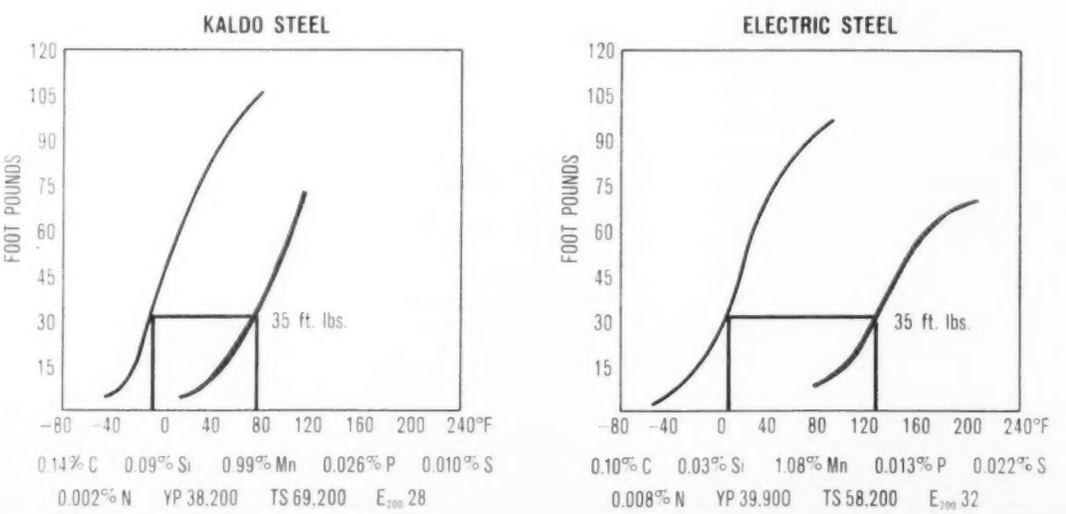


Figure 13 — Curves give impact strength (Charpy v-notch) on 1-in. plate (top of ingots) for normalized steel (solid lines). Dotted lines give same data for normalized and aged (10 per cent strained + 482 F, 1 hr).

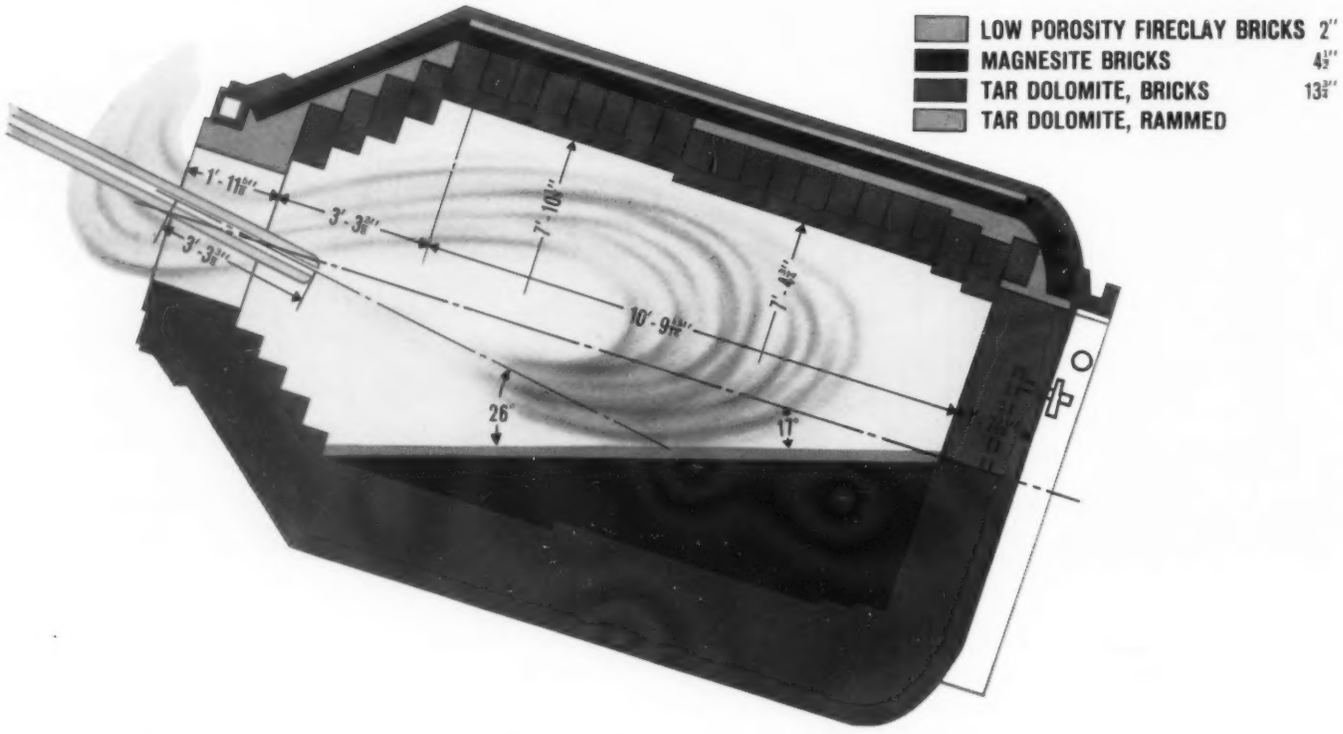


Figure 14 — Sketch shows lining of furnace at Domnarvet. Swedish lining practice is not the same as that in the U. S.

nonaging deep drawing sheets stabilized with vanadium and boron the low nitrogen content is valuable. With a low nitrogen content, the quantity of these additions can be reduced, giving lower costs and less risk of the additions interfering with the rimming action.

The exceptionally low content of sulphur, which is an outstanding feature of the steel, is an advantage for quality in several respects, i.e., the good hot workability of steels including those with low manganese contents, and improved weldability. Production has shown a 75 per cent sulphur removal in high phosphorous hot metal and a 50 per cent removal in basic open hearth iron.

Close control of the temperature can be obtained in the process. The burning of the CO inside the furnace makes possible a rapid increase in the temperature when necessary and vessel rotation with no oxygen blow can be used to reduce temperature quickly. This is of value in the control of tapping temperature and the resultant production of clean steel with good ingot surfaces.

A large quantity of hot rolled sheets for deep drawing has been successfully produced from the steel. Practical comparisons of cold-rolled sheet for deep drawing have shown less rejection for the steel than for open hearth steel. The improved ductility of the steel has also shown up in wire drawing, where it has been possible to use greater reductions than with other steels. The steel is used for welding electrodes where the low sulphur content is a decided advantage.

Most Domnarvet Kaldo steel is rolled to ship plates, which have been approved for all specifications of Lloyds Register of Shipping and other inspection organizations.

Impact resistance properties of the steel after stretching and artificial aging, are noticeably superior to electric steel of the same grade. Examples are given in Figures 12 and 13.

LINING

At Domnarvet the working lining consists of a 14-in. thick layer of tar-dolomite bricks. The permanent lining is made of a 4½-in. layer of burned magnesite bricks over 2 in. of firebrick which is against the shell. A 2-in. layer of tar-dolomite is rammed between the magnesite brick and the dolomite brick linings.

A lining life of 65 heats has been considered satisfactory under Swedish economic conditions, especially when compared to the lining life of the Thomas converters. The lining material, the brick making procedure and the brick laying procedure show much room for improvement when compared to American practices.

Of the factors which affect the lining life, the slag volume and the refractory temperature appear to be the most important. When blowing a high phosphorous pig iron a large slag volume is necessary and it contributes to a low lining life than would be obtained with a low phosphorous pig iron. The higher temperature obtained when burning the carbon monoxide to carbon dioxide in the furnace contributes to lining deterioration. On the

TABLE III
Estimated Production in Two Kaldo Furnaces When Using Basic Bessemer Pig Iron with Ore Cooling

Weight of ingots, tons per heat	29	100
Time for:		
Charging hot metal and additions, min	8	10
Blowing, min	40	60
Slag-off, sampling tapping, min	20	25
Total time, min	68	95
Production, tons per hr	26	63
Tons per year (7500 hr)	200,000	475,000

other hand, the high speed of rotation does not appreciably affect the lining life.

PRODUCTION

At Domnarvet the output is 15 to 16 heats per 24 hr, equivalent to 19 tons of steel per hour. Time from tap-to-tap is about 90 min, of which about 40 min is blowing time. The remaining time is required for slag-taps and sampling (about 30 to 35 min), and for charging hot metal and additions (20 min).

A reduction of the total time can be obtained by better arrangements for charging ore, scrap and lime in a new plant. Table III shows the times calculated for a furnace of the present capacity, 29 tons of ingots, and for a plant calculated for a capacity of 100 tons, both utilizing the one phosphorous slag technique.

SPECIAL FIELDS OF APPLICATION

It is possible to use the furnace for prerefining pig iron for open hearth and electrical steel furnaces. This procedure normally will be more expensive than a direct method, but may be justified under certain conditions. It is possible to obtain a high steel yield, as the iron content in the slag can be brought down to about 2 per cent before slag-off. A better heat economy also is obtained, compared to prerefining in a basic bessemer converter.

The furnace can be used, too, for transforming high phosphorous iron into cast iron. This problem is of current interest in England, and some experiments have been carried out in co-operation with British Cast Iron Research Association (BCIRA).

As dephosphorization requires a content of iron oxide in the slag that is higher than the content corresponding to the equilibrium with the carbon dissolved in the melt, it is impossible to avoid a decrease also of the carbon content during the dephosphorization. It is possible, however, when making cast iron, to recarburize the melt with coke after finished dephosphorization and slag-tapping, without too high reduction of phosphorus from the remaining slag.

The results of the experiments were published recently. See item 6 of Bibliography.

PART II

The metallurgical characteristics of the process have established certain areas of interest in the United States. Although the process was developed primarily for the purpose of making high quality steel from pig iron with high phosphorous content it can produce high quality steel in a broad range of specifications from raw materials of variable composition.

No process, however, for the manufacture of any product can be of general interest if it possesses technological advantage only. It must also be capable of performing an economic function at least as efficiently as do other generally similar processes. This process does.

Plant designs have been prepared; heat and material balances have been completed; operating schedules have been developed, and economic analyses have been made for the process for a number of proposed installations in the United States. In all these cases the economic advantage can be clearly demonstrated.

The economics applied to Western Hemisphere steelmaking operations are based upon a thorough evaluation of operations at Domnarvet in Sweden, combined with conservative extrapolations and projections. At Domnarvet, producing ingots with the process costs less than when using basic bessemers. This cost comparison includes all costs and demonstrates the economic status under the conditions prevailing at Domnarvet. As a result of the experience there, the management of Stora Kopparbergs has scheduled replacement of the basic bessemer converters with the process.

The plant designs that have been prepared for American steel companies contemplate completely new facilities, including buildings; extension of existing buildings to house the process equipment; or installation of process facilities in existing structures such as open hearth furnace shops. The space requirements for the furnaces are minimal. These requirements are such that it has been found feasible to install such furnaces in old open hearth furnace shop buildings.

As a consequence of the metallurgical and operating efficiency of the process combined with its minimal space requirements, capital investment for plants is low. When compared with the capital requirements for a new open hearth shop of similar capacity and with identical auxiliaries, it is found that the requirements are 50 to 65 per cent lower. For Kaldo plants producing in the range of 1,000,000 ingot tons per year where existing open hearth shop buildings, cranes, etc., will be used, capital requirements for the Kaldo process facilities will range downward from $8 per annual ingot ton.

The capability of the process to remove impurities selectively from pig iron has interesting implications from an economic point of view. Certain types of iron ore previously considered undesirable, if not impossible to use, and consequently available at low cost, can now be considered for raw material. Less stringent requirements for pig iron composition will also permit a different and more economical approach toward blast furnace operation.

The oxygen in this process is injected into the furnace at the low pressure of 45 to 50 psi. There is little impingement of oxygen upon molten metal, and the reaction at the slag metal interface corresponds to that found in the open hearth furnace. For this reason a minimum amount of iron or iron-bearing material is lost in the stack gases. Furthermore, the rotation of the furnace makes the iron content of the slag a controllable factor. This results in a minimum loss of iron units in the slag. These two factors contribute to high yield and its consequent effect upon economics.

The facet of the process, which perhaps has greatest impact on the economics of its operation, is heat economy. Between 80 and 90 per cent of the carbon monoxide which evolves during the reaction is converted to carbon dioxide inside the furnace. This conversion contributes substantially to the amount of heat which is available to melt scrap, sinter or ore. The heat from this conversion is absorbed by the refractory lining in the space above the bath, and in turn the heat is given up to the bath as the furnace rotates. With pig iron of an average composition, when making low carbon steel, scrap in excess of 40 per cent of the total metallics charged can be melted. Under those same average conditions the Fe from sinter or ore can contribute approxi-

mately 10 per cent of the total metallics charged. This means that for one ton of pig iron approximately one and one half tons of steel can be made when charging scrap, and approximately one ton of steel per ton of pig iron when charging ore or sinter. This factor relates importantly to operating costs per ton of steel ingot as well as capital requirements per annual ton.

The CO to CO_2 conversion has economic bearing in another direction. When the carbon monoxide content in the gas issuing from the mouth of the furnace is at a minimum, in the magnitude of 10 per cent, a minimum amount of atmospheric air must be inspirated to convert the carbon monoxide to carbon dioxide in the exhaust stack. This results in a low gas volume and the resultant minimizing of gas cleaning equipment capital and operating costs.

SUMMARY

These economic characteristics of the Kaldo process, as well as its metallurgical features, have been used in evaluating the over-all effect of incorporating the process in a number of steel plants in the United States. In each of these cases, the predictions are definitive in both the metallurgical and economic areas.

Because the outcome of these evaluations depends so completely upon all of the conditions prevailing in a specific plant being studied, they cannot be used as the basis for predicting the consequence of using the process in all steel plants.

On the other hand, a review of both its metallurgical and economic characteristics leads to the logical conclusion that its application will have a beneficial effect on American steelmaking operations.

1. The process has satisfactorily produced high quality steel in a broad range of specifications from feed material of varying composition.

2. The open-hearth type of reaction inherent with the process, combined with the rotational characteristic of the furnace, permits considerable selectivity in the elimination of metaloids; and produces low phosphorous, low nitrogen and low sulphur steel at easy to control tapping temperatures.

3. The control of rotation of the vessel and its consequent influence on composition, temperature and foaming produces slag with low iron content, thus contributing to high yield.

4. The ease with which carbon is caught at a predetermined point minimizes time required for carbon control and eliminates the necessity for recarburization.

5. The low pressure at which oxygen is injected into the furnace produces a quiet reaction and a consequent minimizing of iron loss in exhaust gases.

6. Conservatively estimated, the blowing rate will approximate three tons per minute with average United States pig iron and when charging scrap.

7. Yields in excess of 90 per cent will be customary in most American applications.

8. Combustion of essentially all of the carbon monoxide to carbon dioxide within the furnace minimizes gas volume and the cost of cleaning thereof, and at the same time, permits the melting of large quantities of iron ore, sinter or scrap.

BIBLIOGRAPHY

1. "New Oxygen Steelmaking Process Cuts Cost; Boosts Quality," Iron Age, Oct. 18, 1956, pp. 126–129.
2. "The Rotary Oxygen Steel-making Process," by Bo Kalling and Folke Johansson, paper presented at the United Nations ECLA Meeting in Sao Paulo, October, 1956, The Iron and Coal Trades Review, Dec. 21, 1956, No. 4622, pp. 1497–1499.
3. "Swedish Oxygen Steelmaking," by Folke Johansson, Journal of Metals, July, 1957, pp. 972–975.
4. "Syrgasfarskning i roterande ugn enligt Kaldo-processen," by Bo Kalling and Folke Johansson, Jernkontorets Annaler, vol. 141, 1957, pp. 189–205.
5. "Frischen mit Sauerstoff im Drehofen nach dem Kaldo-Verfahren," by Bo Kalling and Folke Johansson, Stahl und Eisen, Vol. 77, 1957, pp. 1308–1315 and 1885–1887.
6. "Production of Low Phosphorus Foundry Iron from High Phosphorus Iron Ores," by R. I. Higgins, to be published in the Journal of Research and Development of the British Cast Iron Research Association.

APPENDIX I

MATERIAL AND HEAD BALANCE

The calculations below are not based on a special heat but on a normal heat cycle with the average analysis and the additions of lime and sinter that are generally used for basic bessemer pig iron.

Charged per 1000 lb of pig iron:

1000 lb of pig iron containing by percentage 3.6 C, 0.3 Si, 0.7 Mn, 1.85 P, 0.25 V.

150 lb of sinter containing by percentage 55.6 Fe, 22.9 O, 7.8 SiO_2, 7.4 CaO, 3.2 MgO, 0.7 MnO, 0.14 P_2O_5, 2.1 other components.

140 lb of lime containing by percentage 88.0 CaO, 3.7 SiO_2, 0.9 MgO, 5.0 CO_2, 2.4 other components.

Slag	SiO_2	CaO	MgO	FeO	MnO	P_2O_5	Other components	Total
From pig iron	6.4	...	...	20.6	7.7	41.9	3.7	80.3
From sinter	11.7	11.1	5.0	...	1.0	0.2	3.0	32.0
From lime	5.0	118.8	1.2	...	...	...	3.2	128.2
From lining	...	11.0	8.0	...	...	1.0	...	20.0
Total	23.1	140.9	14.2	20.6	8.7	43.1	9.9	260.5
Average analysis	8.9	54.1	5.4	7.9	3.3	16.6	3.8	

20 lb of lining containing 40 per cent MgO, 55 per cent CaO, 5 per cent other components.

The consumption of oxygen can be estimated as follows:

Steel percentage analysis after blowing 0.10 C, 0.10 Mn, 0.02 P.
Iron as oxide in slag 16 lb.
Iron as oxide in fumes 5 lb.

75 per cent of the carbon contained in the pig iron is burned to carbon dioxide.
Reaction:

		Lb O_2 per 1000 lb iron
C.....CO	0.25·35·1.33	11.6
C.....CO_2	0.75·35·2.66	69.8
Si.....SiO_2	3·1.14	3.4
Mn.....MnO	6·0.291	1.7
P.....P_2O_5	18.3·1.29	23.6
V.....V_2O_3	2.5·0.471	1.2
Fe.....FeO	21·0.287	6.0
		117.3
From sintered added 150·0.229		34.4
From oxygen inserted (balance) = 980 cu ft (32 F, 760 mm) oxygen with 95 per cent O_2		82.9

Obtained per 1000 lb of pig iron:

Steel from pig iron 1000 − 65		935 lb
Steel from sinter 150 × 0.55		83 lb
Iron losses in slag and fumes		21 lb
Molten steel before alloys added		997 lb
Fumes: 5 lb of lime		
7 lb of iron oxide with 5 lb of Fe		
Exhaust gases:		
From carbon in pig iron	0.25·35·2.33	20.4 lb CO
	0.75·35·3.66	96.1 lb CO_2
From lime added	0.05·140	7.0 lb CO_2
From oxygen	0.05·980	49 cu ft N_2

Total:

	Mol	Average volume, per cent
CO	0.73	22.7
CO_2	2.34	72.9
N_2	0.14	4.4
	3.21	100.00

Heat input:

			10,000 Btu per 1000 lb of pig iron
Heat content of pig iron (2280 F)			487
Heat from chemical reactions:			
26.2 kg C from Fe_3C.....CO_2 + Fe	26.2·14,850	388	
8.8 kg C from Fe_3C.....CO + Fe	8.8· 4,710	41	
3.0 kg Si from FeSi.....$2CaOSiO_2$ + Fe	3.0·14,090	42	
6.0 kg Mn.....MnO	6.0· 3,020	18	
18.3 kg P from Fe_3P.....$3CaO·P_2O_5$ + Fe	18.3·12,930	237	
2.5 kg V.....V_2O_3	2.5· 5.650	14	740
Total heat input			1227

Heat output:

Heat in steel, 2966 F	997·606	604
Heat in slag and fumes	272·880	239
Heat in exhaust gases at (1)	96.9·41.400	
3300 F (estimated)	22.1·25.400	119
Reduction of Fe_2O_3...Fe	62·3216	119
Furnace losses (balance)		66
		1227

(1) Excluding heat in unburnt CO = 0.73·121.8 = 88.9·10,000 Btu
Physical and chemical heat in exhaust gases together 208·10,000 Btu

CURRENT AISE DISTRICT SECTION MEETING NOTICES

BIRMINGHAM SECTION

Saturday, May 23, 1959—1:30 P.M.

Annual Stag Picnic

Pearl Lake, Birmingham, Ala.

BUFFALO SECTION

No May Meeting

CANTON SECTION

Monday, May 18, 1959—Social Hour 6:30 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"Hydraulic Jet Descaling," by Benj. G. Harmon, Senior Partner, Harmon & Co., Chicago, Ill., and Robert V. Proctor, Vice President & Chief Engineer, Commercial Shearing & Stamping Co., Youngstown, Ohio

Merges Restaurant, Canton, Ohio

CHICAGO SECTION

Tuesday, May 5, 1959

Inspection Trip 2:30 P.M.
Dinner 7:00 P.M.
Meeting 8:00 P.M.

Inspection Trip: Republic Steel Corp.'s New 11-In. Bar Mill, Chicago, Ill. Buses will leave Phil Smidt's Restaurant at 2:30 P.M. and will return there after inspection trip.

"Republic's Bar Mill of Tomorrow," by D. E. Weaver, Superintendent, Finishing Mills, and H. E. Berg, Chief Engineer, Chicago District, Republic Steel Corp., Chicago, Ill.

Dinner and Meeting, Phil Smidt's Restaurant, 1205 North Calumet Ave., Hammond, Ind.

CLEVELAND SECTION

No May Meeting

DETROIT SECTION

No May Meeting

LOS ANGELES SECTION

Data Not Available

PHILADELPHIA SECTION

No May Meeting

PITTSBURGH SECTION

No May Meeting

ST. LOUIS SECTION

Wednesday, May 27—7:00 P.M.

Inspection Trip through Chevrolet Assembly Plant, General Motors Corp., at Natural Bridge and Union Avenue, St. Louis, Mo.

SAN FRANCISCO SECTION

Friday, May 8, 1959

Golf Tournament, Diablo Country Club, Danville, Calif.

Tuesday, May 19, 1959—Social Hour 6:00 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

Bethlehem Pacific Coast Steel Corp. Night

"Simplified Records Aid Progressive Maintenance," by D. M. Petty, Jr., Superintendent, Mechanical and Electrical Dept., South San Francisco Plant, Bethlehem Pacific Coast Steel Corp., San Francisco, Calif.

Shattuck Hotel, Shattuck & Alston Way, Berkeley, Calif.

UTAH SECTION

Utah District

Monday, May 11, 1959—Social Hour 6:30 P.M., Dinner 7:30 P.M., Meeting 8:30 P.M.

"Operation of Basic Oxygen Furnace at Aliquippa Works," by D. R. Loughrey, Co-ordinator—Steelmaking, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

Grandview Cafe, Provo, Utah

Pueblo District

Monday, May 18, 1959—Social Hour 6:30 P.M., Dinner 7:30 P.M., Meeting 8:30 P.M.

"14-In. Mill Modernization," by Rudolph Hunze, Engineer, The Colorado Fuel and Iron Corp., Pueblo, Colo.

Minnequa University Club, Pueblo, Colo.

YOUNGSTOWN SECTION

Monday, May 25, 1959—Social Hour 6:30 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

Inspection Trip—3:00 P.M., New Sintering Plant, Ohio Works, United States Steel Corp., Youngstown, Ohio (Meet at Ohio Works).

"Construction and Design Considerations Involved in the New Sintering Plant," by Richard Patton, Project Engineer, Ohio Works, United States Steel Corp., Youngstown, Ohio

"Production in the New Plant," by Fred M. Farragher, Superintendent Auxiliaries—Blast Furnace, Ohio Works, United States Steel Corp., Youngstown, Ohio

Dinner and Meeting, Mural Room, Youngstown, Ohio

by A. Donald Shattuck,
Superintendent, Coke Plant,
Great Lakes Steel Corp.,
Ecorse,
Detroit, Mich.

Figure 1 — Because the sub-soils adjacent to the dock did not permit construction of large receiving hoppers, a small 26-ft cylindrical surge hopper was provided 135 ft from the dock face.

New Material Handling Facilities

. . . . Great Lakes limestone and coal handling equipment for unloading vessels and stocking is an interesting design

SEVERAL years ago it became apparent to several major steel producers including National Steel's Detroit unit, Great Lakes Steel Corp., that their source of quality flux stone for blast furnaces was fast becoming depleted, and a new source would have to be found within the next two years. Accordingly, a search of the Great Lakes area was made, and shortly plans were under way to quarry property controlled by the Kelley Island Limestone & Transport Co. in Presque Isle County, approximately 20 miles north of Alpena, Mich. This venture, including vessel docking facilities, crushing, screening, stockpiling, blending, and finally vessel-loading equipment, was financed jointly by four competing steel producers and National Steel Corp.

This new source of limestone required drastic changes in handling at Great Lakes. Previously all stone was delivered daily via hopper car but now it would be delivered by self-unloading vessels during the navigation period, April through November. It meant stockpiling of stone for use through the winter months.

At this time a new coke plant was under construction at Great Lakes, and additional coal storage capacity was being sought. Consequently, suitable area was set aside for storage of up to 400,000 tons of limestone and 350,000 tons of coal. The area was an irregularly-shaped plot, approximately 1600 ft deep, 765 ft across the dock face, and approximately 300 ft wide at the extreme depth.

Before designing equipment necessary to receive and

Figure 2 — As coal or limestone is received by the surge hopper, it is gravity fed onto 72-in. feeder belt No. 1.

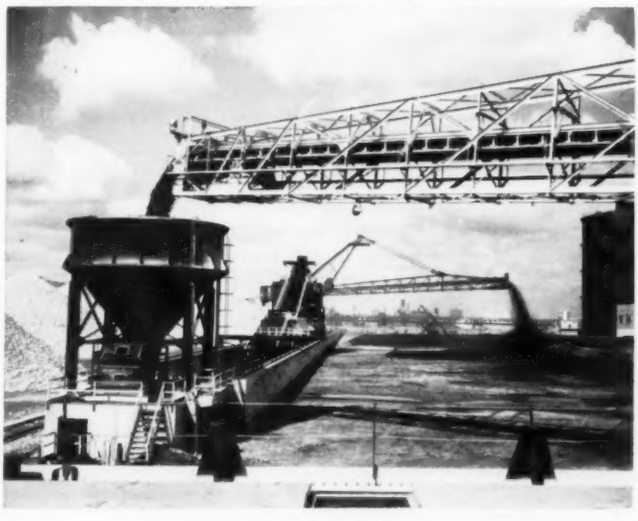
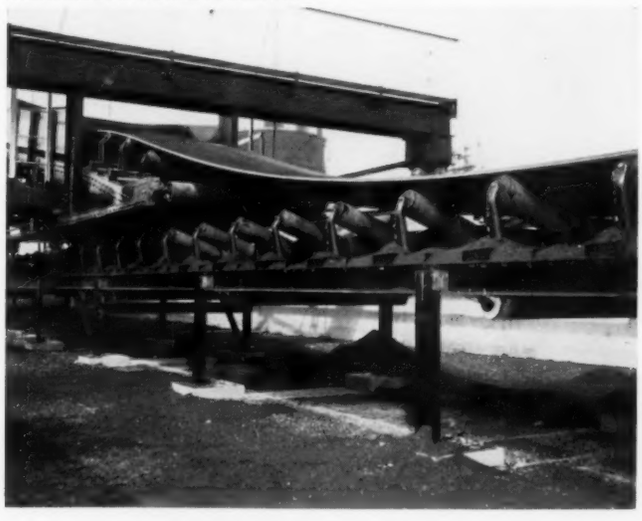


Figure 3 — Feeder belt No. 2 climbs up into the rail-mounted removable stacker.



stock such tonnages, vessel capacities were studied. Most late model self-unloaders plus some then projected on drawing boards called for carrier capacities in excess of 20,000 tons and unloading rates of 4500 tons of limestone per hr at 90 lb per cu ft, and 2500 tons of coal per hr at 50 lb per cu ft. As space and sub-soils adjacent to the dock did not permit construction of large receiving hoppers or storage at the dock face, a small 26-ft diam 380-ton capacity cylindrical surge hopper, Figure 1, was provided 135 ft from the dock face. All conveying equipment to final storage was designed to convey the material at the 4500-ton per hr stone rate and 2500-ton per hr coal rate.

As coal or limestone is received, it is gravity fed through a manually adjustable rack and pinion gate plate near the bottom of the surge hopper onto a 72-in. feeder belt No. 1, Figure 2. This belt, 12 ft between the 36-in. diam cast iron drive and take up pulleys, contains six straight plies of 42-oz duck. It has a $\frac{1}{2}$-in. top rubber cover with two transcord breaker strips and an $\frac{1}{8}$ in. bottom rubber cover with one transcord breaker strip. The belt travels at a speed of 133 fpm, and is powered by a 25-hp 1200 rpm motor through a high-speed flexible coupling, a 42 to 1-ratio herringbone-gear speed reducer, and sprockets with steel bushed roller chain drive. The No. 1 belt delivers the material to the 60-in. trunk line conveyor No. 2, Figure 3. This belt, 1210 ft between pulleys, contains seven straight plies of 42-oz duck, $\frac{3}{8}$-in. top rubber cover and $\frac{3}{32}$-in. bottom rubber cover also, both with transcord breaker strips. It travels 600 fpm, lifts 15 ft over a tripper for delivery of material to the stacker trailer conveyor No. 3 (Figure 4) and is powered by two, 200-hp, 720-rpm motors. The drive pulley, fitted with grooved lagging is of high test cast iron construction, is 48 in. in diam, and is driven by two 13.3 to 1 ratio herringbone-gear speed reducers, V-belt driven direct from motor sheaves. Couplings are low-speed flexibles.

The stacker trailer conveyor No. 3, receiving material from the trunkline conveyor No. 2, over the tripper, is 60 in. wide and 186 ft between pulleys. It has a speed of 650 fpm and a total lift of about 51 ft. Conveyor belt construction, pulleys, motors, drives, couplings, etc., are identical to those of the trunkline conveyor No. 2. In addition, torque type motor brakes are provided to prevent the belt from rolling backward if stopped under load.

Figure 4 — The No. 1 feeder belt delivers the material to the 60-in. trunk line conveyor No. 2 which elevates the material 15 ft before delivering it to the stacker trailer conveyor No. 3 for a final 51-ft elevation to the boom conveyor.

Figure 5 — This 60-in boom conveyor has a length of 137 ft, a speed of 65 fpm, and a 38-ft lift.

The trailer conveyor No. 3 discharges to the 60-in. boom conveyor No. 4, 137 ft between pulleys, traveling at a speed of 650 fpm and having a total lift of about 38 ft. The boom conveyor No. 4, shown in Figure 5, is also equipped with a 48-in. lagged, cast iron drive pulley, requires a 300-hp, 1200-rpm motor, has a high-speed flexible coupling, and a herringbone-gear speed reducer with ratio of 8 to 1, and is gear-driven. It is also equipped with a torque type brake.

The 72-in. feeder belt No. 1 is equipped with straight eight-in. diam, 72-in. long rubber-covered conveyor idlers on 12-in. centers. No return idlers are furnished for this short belt. All other conveyors are equipped with three 60-in., rubber-disk-cushion idlers located at the loading end of the conveyor and 60-in., roller bearing trougher idlers on approximate 3-ft centers throughout the system. The return idlers on 60-in. belts are the standard roller bearing type on 10-ft centers. Twelve 60-in. return training idlers are installed on the 1210-ft trunk line conveyor No. 2 and three on the boom conveyor No. 4.

The 72-in. feeder belt No. 1 and the boom conveyor No. 4 are fitted with roller bearing, protected screw take-up units while the trunk line conveyor No. 2 and the trailer conveyor No. 3 are equipped with gravity take-up frames with concerte tension weights. Belts are supplied with counterweighted belt scrapers and snub and bend pulleys were required. All conveyor belts with the exception of the 72-in. feeder belt are field vulcanized. The feeder belt is spliced with No. $2\frac{1}{2}$ strip fasteners. The cylindrical surge hopper is constructed of $\frac{3}{8}$-in. steel plate with $\frac{1}{2}$-in. liner plate, and all transfer chutes are constructed of $\frac{5}{16}$-in. steel plate and are also fitted with the $\frac{1}{2}$-in. liner plate. Chutes are covered with $\frac{3}{16}$-in. plate.

The traveling stacker is erected on 100-lb rails mounted on two heavily reinforced concrete walls, 10 ft above grade level, spaced 30 ft apart and running the length of the storage area. The unit with an over-all height of 72 ft above the rails is in length, 250 ft from

tail of tripper to turntable kingpin. Boom length is 140 ft.

Traversing equipment of stacker proper consists of four, 4-wheel trucks, two trucks per rail. All wheels are double-flanged, 24-in. diam. One 20-hp 1200-rpm double-shafted motor per truck propels two wheels through a fully enclosed worm drive. The motors are equipped with solenoid-operated shoe brakes. Traveling speed of the stacker is 50 fpm.

The boom may be hoisted plus 16 degrees from the horizontal in order to build high piles, approximately 65 ft being maximum, or may be lowered to minus 7 degrees in an effort to minimize degradation. The boom hoisting equipment consists of conventional $\frac{7}{8}$-in. wire rope, sheaves, drum with ring gear, a 50 to 1 ratio cone drive with pinion, coupling, 40-hp 1020-rpm motor, and a brake with wheel and enclosure.

The stacker turntable, Figure 6, consists of a single, tapered, flat, 8-in. wide track 30 ft-4½ in. in diam securely bolted to the structure. Also bolted to this structure is the king pin assembly on which the boom structure pivots or slews. Four 2-wheel trucks are mounted on the boom structure. The wheels, 24 in. in diam, are flat, tapered and have their axes placed so that all ride the 30 ft, 4½-in. diam circle track. These four 2-wheel trucks carry the combined weight of the boom and counterweight. The boom slewing mechanism, mounted on boom counterweight platform, consists of a 10-hp, 1040-rpm motor with brake, a No. 2 standard coupling, a 250- ratio cone gear drive with pinion, drum shaft and gear. Wire rope, $1\frac{3}{8}$ in. in diam, from the drum shaft through suitable self-lubricating sheaves and around the periphery of turn table, provides the medium for boom slew. Its rope speed is 7.7 fpm.

Safety features throughout the system are many and varied. All possible safeguards to employee as well as equipment are installed. Rubber skirting as well as metal skirt boards protect from flying material at all impact points. Metal skirting throughout all inclined conveyors protect against rolling material. All transfer chutes are totally enclosed with inspection doors available. An electronic bin level indicator is installed in the cylindrical hopper with a signal system to alert vessel employees of stocking difficulties thereby insuring against overflow of hopper. Emergency pushbutton stop switches are conveniently spaced along the galleries. Countless limit switches protect the stacker from over-travel at either end of the runway and protect the boom from overtravel in slewing as well as hoisting and lowering. When the stacker is taken out of service, the boom is lowered to rest on saddle provided atop a heavy duty horizontal gravity take-up frame for trunkline conveyor No. 2. Interlocking is provided to prevent slewing of the boom when entering or leaving this zone at the far end of runway. Two identical operating cabs are provided in the trailer tower facing opposite sides of the stacker runway. This insures adequate vision for the operator regardless of which side of the runway wall is being stocked. A pushbutton signal system is provided between operating cabs and all walkways and ladders leading to the stacker to notify the operator when employees wish to board the stacker.

A cup type anemometer is provided on a standard above the high point of the stacker structure. The

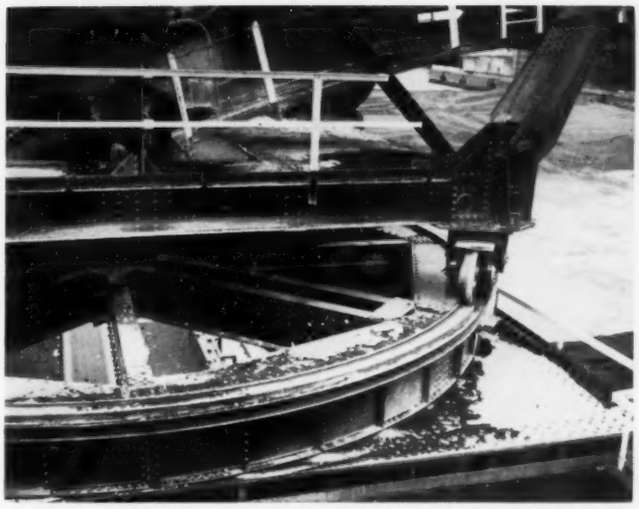


Figure 6 — Four two-wheel trucks pivot the boom on a 30-ft, 40½-in. diam circular track.

anemometer is interlocked with two self-adjusting, single, automatic rail clamps installed on opposite non-propelled wheels of the stacker. This interlock prevents release of clamps and operates a signal light and horn when wind velocity reaches 35 mphr. When this occurs, the operator immediately stops the flow of material, slews his boom directly into the wind and traverses the stacker to the out-of-service area when wind velocity permits. The anemometer is the generator type and is equipped with a recorder which is mounted in the electrical switch room on the stacker trailer structure (Figure 7). It graphically records wind velocities.

The National Steel Corp.'s 1956 announcement of new ore preparation and sintering facilities at Great Lakes Steel caused considerable alteration of the coal and limestone handling system. Necessarily the No. 3 ore storage yard had to be extended the width of the coal and limestone storage area at the dock face,

Figure 7 — The anemometer mounted on the top of the stacker is equipped with a recorder located in the electrical switch room of the stacker.

approximately 650 ft. This extension forced the relocating of the cylindrical receiving hopper to a point approximtely 300 ft south of the original location, and a portion of the original trunkline conveyor No. 2 had to be moved also. A new trunkline conveyor will be built to tie the relocated portion of the system to the remaining original trunkline conveyor No. 2 with adequate junctions and chutes.

The completion of the new No. 1 blast furnace changed storage requirements for limestone somewhat from the original estimates so that the coal and limestone storage yard tonnages at the end of navigation, November, 1956, was predicted in March, 1956, to be 500,000 tons of stone and about 150,000 tons of coal. The daily requirement of limestone is reclaimed from storage with two caterpillar shovels with two yard dippers. A caterpiller crane of identical design with a three-yard re-handler clam shell bucket reclaims coal. Seventy-ton hopper cars are provided for this service.

Discussion

PRESENTED BY

W. J. REILLY, General Manager, Steel Division, Ford Motor Co., Dearborn, Mich.

A. DONALD SHATTUCK, Superintendent, Coke Plant, Great Lakes Steel Corp., Ecorse, Detroit, Mich.

W. J. Reilly: What is your minimum distance from the dock face for piling materials? Where is your wall? How far back is it?

A. Donald Shattuck: At the present time we are storing material on the limestone dock about 400 ft back from the dock face. The dock face has not been piled. Where there is suitable piling, we bring stock right out as close to the dock face as we can where it is not piled. ▲

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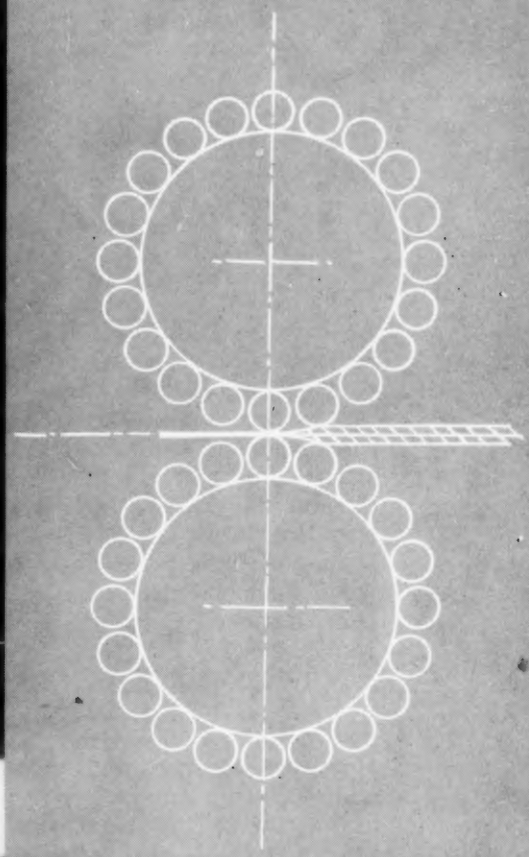


ATLAS STEELS Ltd.

ATLAS STEELS
LIMITED

by T. J. Ess

TODAY'S Atlas Steels Limited puts its beginning in 1928, when R. H. Davis cast his lot with the future of Canadian industry and acquired Canadian Atlas Steels at Welland, Ontario.

Actually, the nucleus of the organization was a small company known as Dillon Crucible Alloys, Ltd., started during World War I. This did not last after the war, but various attempts were made to resume operation during the next few years. The rather spotty history of those years shows the names of Canadian Atlas Crucible Steel Co., Atlas Crucible Steel Co. and Atlas Steel Corp., the last two headquartered at Dunkirk, N.Y.

In 1928, Canadian Atlas Steels was producing some tool and specialty steels but the plant was small and poorly equipped. There were 35 people on the payroll. However, transportation, power and water supplies and available manpower were good. Mr. Davis began an improvement program which has continued to the present day. He also began with an annual profit—small, true enough, but a profit, nevertheless. An annual profit has also continued—even through the painful thirties—to the present day. About 68 per cent of the profits have been put back into the business.

Expansion, diversification, improvement and foresighted management have brought Atlas to a high position in Canadian industry. It is the largest producer of specialty steels in the British Commonwealth. It has approximately 1800 on its payroll.

The company has an aggressive sales program, with a world-wide organization of warehouses and representatives. Approximately 20 per cent of its production is exported from Canada, a fact which has contributed to company growth. There is also a working agreement with Usines Gilson, S. A., in Belgium, also a specialty steel producer with facilities quite similar to those of Atlas. Atlas owns about one-third of the Belgian company and close technical liason is maintained between the two.

Atlas today produces tool steels, high-speed steels, drill steels, special purpose steels, stainless steels and constructional steels. Its product mix includes billets, bars, strip, sheet, plate, wire, tubing and forgings. In addition, some finished products such as hollow drill bars, tool bits, machined forgings, etc., are made.

The Welland plant is located on a site of about 250 acres on the Canadian National Railway and about one-half mile from the Welland Canal. It is laid out in two principal units called the North plant and the

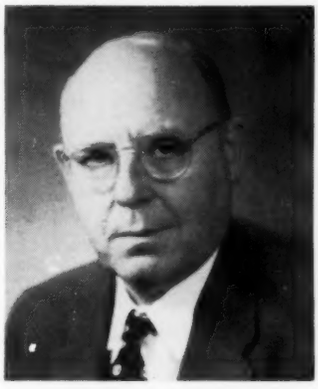
All steel produced at Atlas comes from electric furnaces. There are six arc furnaces ranging 6 to 50 tons in capacity and three induction furnaces of 100 to 600 lb capacity. Here a floor type charger is charging an arc furnace.

H. GEORGE DE YOUNG
President

W. A. THOMAS
Vice President—Operations

H. B. CHAMBERS
Vice President—Metallurgy

G. C. OLSON
Plant Superintendent



T. J. NOLAN
Chief Engineer

D. V. ROLAND
Maintenance & Utilities

South plant. The former includes the melt shop, bloom and billet mills, sheet mill, cold draw department, strip and tube mills, with their related finishing equipment, as well as the central maintenance shops. The South plant consists of bar mills, finishing equipment and some miscellaneous manufacturing facilities.

ELECTRIC FURNACES

Steelmaking facilities at Atlas consist entirely of electric furnaces. Six arc furnaces and three small induction furnaces provide an annual capacity of 200,000 net tons.

The induction furnaces, of 600-lb, 350-lb and 100-lb capacities, are used principally for small heats for research and experimental purposes. These furnaces receive power from a 175/200-kva, 1475-cycle, high frequency generator, driven by a 250-hp, 2300-volt, 450-rpm, 60-cycle synchronous motor.

Details of the arc furnaces follow:

A furnace—6 tons, 9-ft shell diam, 6 ft-11½ in. high, 1500-kva transformer. Primary 4150 volts, 3-phase, 25 cycle. Secondary voltages 235 to 92. Lead cables: 12 per phase, 1,000,000 circular mils each. Oil circuit breaker 7.5 kv, 2000 amp. Three 10-in. electrodes. Weight tapped 10,000 to 14,000 lb. Installed in 1931.

B furnace—10 tons, 12-ft shell diam, 7 ft-6¼ in. high, 4000-kva transformer. Primary 4150 volts, 3-phase, 25 cycle. Secondary voltages 235 to 92. Lead cables: 16 per phase, 1,000,000 circular mils each. Air circuit breaker 7.5 kv, 2000 amp. Three 14-in. electrodes. Weight tapped 25,000 lb. Installed in 1938.

C and D furnaces—30 tons, 14 ft-6 in. shell diam, 9 ft high, 7500 kva transformer. Primary 26,400 volts, 3-phase, 25 cycle. Secondary voltages 250 to 92. Lead cables: 24 per phase, 1,500,000 circular mils each. Oil circuit breaker 35 kv, 2000 amp. Three 16-in. electrodes. Weight tapped 65,000 to 70,000 lb. Installed in 1941.

E furnace—50 tons, 16 ft-6 in. shell diam, 10 ft high, 7500-kva transformer. Primary 26,400 kva, 3-phase, 25 cycle. Secondary voltages 250 to 92. Lead cables: 24 per phase, 1,500,000 circular mils each. Air-blast circuit breaker 35 kv, 1200 amp. Three 18-in. electrodes. Weight tapped 100,000 lb. Installed in 1942.

F furnace—50 tons, 16 ft-6 in. shell diam, 10 ft high. Two 7500-kva transformers in parallel. Primary 26,400 volts, 3-phase, 25 cycle. Secondary voltages 250 to 92. Lead cables: 24 per phase, 1,500,000 circular mils each. Air-blast circuit breaker 35 kv, 1200 amp. Three 18-in. electrodes. Weight tapped 100,000 lb. Installed in 1942.

All of the arc furnaces have welded shells of 1-in. plate. Side walls are of magnesite brick, 13½ in. thick. Roofs are 9 in. thick, of silica brick laid up with paper for expansion joints.

The two small furnaces (A and B) are top-charged, with the roofs being moved aside on gantry cranes and the scrap dropped into the furnace from 141-cu ft buckets carried by overhead crane. The other four furnaces are door-charged by floor type charging machines.

For tapping, the furnaces are tilted on toothed rockers which engage toothed tracks, or racks. The tilting motion is actuated by electric motors through reduction gears.

All furnace transformers are oil-immersed, water cooled. Taps are changed electrically, by remote control from the furnace operating panel. Current is carried from the secondary bus to the electrode arms

on each furnace by air-cooled flexible copper cables, as previously detailed. Electrodes are moved by 5-hp motors controlled by balanced beam current regulators.

The steel produced ranges through more than 200 grades of specialty products, including high-temperature alloys, all types of stainless, high-speed and tool steels, aircraft quality and regular quality low alloy steels.

Steel scrap of the proper analyses is charged into the furnaces, with 60 to 70 per cent in the original charge and the remainder in a recharge after the original material has been partly melted down. Power is applied at 240 volts for melting, and is reduced to 100 to 180 volts during the refining period.

Basic double slag process is generally used, with lime-silica ratios running 2:1 or higher. The first slag is removed by tilting the furnace slightly and raking off slag through the furnace door, allowing it to fall through an opening in the floor to a slag pot below. The second, or reducing, slag is then formed by the addition of lime, fluorspar, sand and fine coke or ferro-silicon. Steel is deoxidized by adding small quantities of aluminum or silicon.

Because of the wide range of analyses produced, extreme care is exercised in testing and segregating scrap for the electric furnaces. In the scrap yard there are alligator shears and oxy-acetylene facilities to cut up heavy scrap. A scrap baler is provided to form bundles of light scrap. Scrap is loaded by cranes into railroad cars and moved to the melt shop, where it is transferred by magnet crane into charging pans or buckets, as desired. Crushing equipment is used to reduce silicon, tungsten, vanadium, titanium, etc., to the desired sizes. Alloys, fluxes, refractories, etc., are stored under the melt shop floor and brought up as needed by industrial trucks and overhead cranes.

Steel tapped from the arc furnaces may proceed in either of two courses. Prior to 1954, all steel was poured into hot-topped big-end-up ingots. Still used regularly are square and corrugated rounds from 7¼ to 52 in. and slab ingots from 17 x 30 in. to 17 x 53 in.

Steel tapped from the tilting arc furnace into ladles of suitable size may be poured into ingot molds or put through the continuous casting machine.

CONTINUOUS CASTING

Early in 1954 Atlas began operation of a continuous casting machine. Based on the Junghans-Rossi principle, this machine is capable of casting any size in the general range of 4 to 8½-in. squares and up to 6⅝ x 24-in. slabs. It is a vertical unit, with the casting floor 31 ft above ground and discharge pit 20 ft deep.

Steel to be cast through this machine is tapped into bottom-pour ladles of 12, 30, 35, or 50-ton capacity. They have 1 in. of insulating brick under 11 in. of standard ladle brick lining and have refractory-lined steel covers.

The preheated ladle is filled with steel from an arc furnace, and is then moved by transfer car to the casting machine. An overhead crane lifts the ladle to the casting floor. As the ladle nozzle is opened, steel flows into a tundish, which acts as a reservoir, immediately above the mold. The liquid metal is at all times protected from oxidation with a propane atmosphere.

The mold, made of pure copper with vertical passages for cooling water is 20 in. long. Atlas now has molds for casting 4¼-in. squares, 6½-in. squares, 5½ x 7½ in., 3¼ x 17½ in., 7 x 15 in., and 6⅝ x 24 in. The smaller sizes are cast in double strand.

At the start, a starting or dummy bar is inserted into the bottom of the mold. As molten steel flows from the tundish into the mold, it is chilled, forming a shell ¼ to ½ in. thick.

Pinch rolls act to pull down the starting bar, followed by the cast slab or billet. Synchronized machinery oscillates the mold vertically through ¾ in., lowering at the same speed as the billet movement and rising at three times this speed. A vegetable oil is constantly injected to provide lubrication between mold and billet.

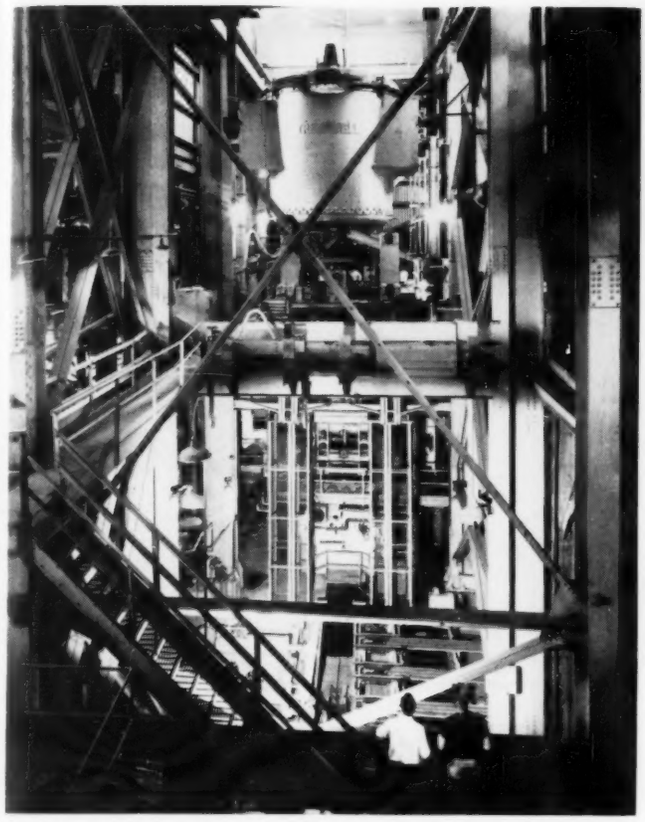
As the billet moves lower, it passes through series of small rollers which contain and support all sides. At the same time, water sprays at 20 to 50 psi pressure impinge on the bar, speeding up cooling.

Below this cooling chamber are two oxy-acetylene torches mounted so they clamp on the billet or slab and travel downward at the same speed as the billet while cutting is in progress. At the desired intervals, the torches go into action to cut the cast billet into desired lengths, up to 16 ft.

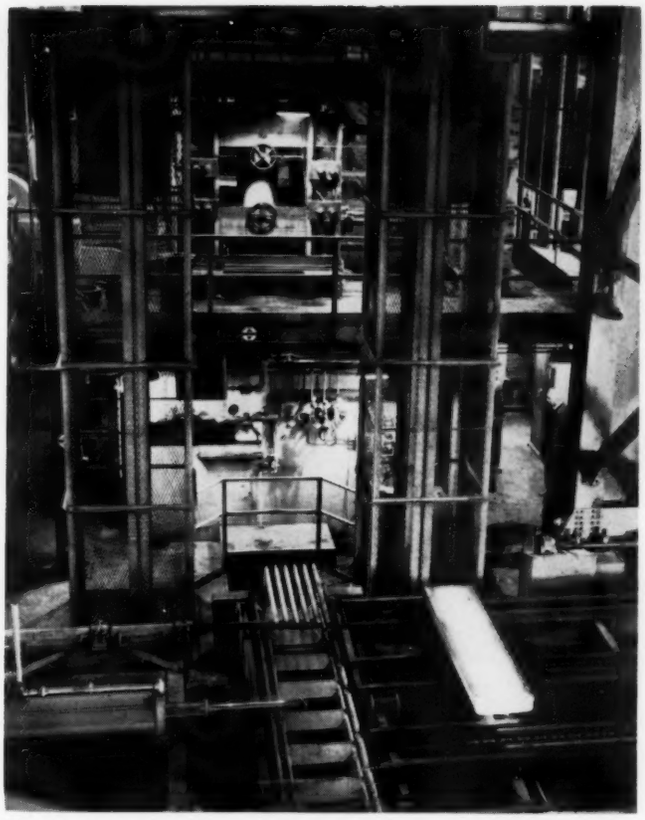
The cut lengths are lowered onto a carrier which brings them back to a cooling bed at ground level. From the pickup cradle, the billets or slabs, now about 1500 F, may be moved to reheating furnaces at the rolling mills.

Casting speed can be set at any desired point up to 175 in. per min. The 6⅝ x 24-in. section has been cast at a rate of more than 50 in. per min, or 60 tons per hr.

Water consumption for mold cooling varies between 100 and 235 gpm. In addition, the water sprays may use between 30 and 1000 gpm, depending on the section being cast, the rate of casting and the steel analysis. For each cut made on 6⅝ x 24-in. stainless slabs, 2½ to 3 cu ft of acetylene, 60 to 75 cu ft of oxygen and 2½ to 3 lb of iron powder are used.



In the continuous casting machine, steel flows from the ladle at the top down through a water-cooled mold. The formed slab or billet proceeds down through cooling sprays and pinch rolls.



In the lower section of the continuous casting machine the slab or billet is flame-cut into lengths which are brought up to a cooling bed transfer at ground level.

BLOOMING MILL

Most of the steel from the melt shop, whether cast into ingots or through the continuous casting machine, is rolled through the blooming mill.

Steel is first reheated in 12 soaking pits, arranged in two banks of six pits each. Each pit is 15 ft long, 5 ft-6 in. wide and 9 ft deep. They are one-way end-fired with natural gas or fuel oil. Air for combustion is provided by two fans, and is not preheated. Products of combustion flow from the pits to a waste-heat boiler.

Steel is charged into the pits and drawn from them by two 2-ton stiff leg pit cranes. Rolling temperatures range 2000 to 2350 F, depending on the kind of steel. Heating time may run 2 to 20 hr, depending on ingot size, its temperature when charged, and grade of steel.

Ingots and cast slabs are carried to the mill approach table by a front-tilt, self-propelled ingot buggy.

The blooming mill is a 26-in. two-high reversing unit. Housing posts are 15 x 22 in. Mill rolls are 26 in. in diam with a 66-in. body length. They run in composition roll neck bearings. The rolls are designed with grooves of 4¼, 5½, 7½ and 11½ in., and an 18⅝-in. bullhead. The top roll is mechanically balanced by counterweights.

Mill pinions are of double helical design, with 1-in. diametral pitch, 26-in. pitch diam and 36-in. face. They operate in babbitted bearings. Mill spindles are 12 in. in diam, and run in composition slipper bearings.

Rolls are raised and lowered by 10½-in. diam screws of 1.5-in. pitch, operated by two 50-hp mill type motors.

The 26-in. mill is driven by a 1750-hp, 600-volt, 60/150-rpm, d-c motor under adjustable voltage control. This motor draws power from a motor-generator set consisting of two 750-kw, 600-volt d-c generators and a 3000-hp, 4150-volt, 750-rpm, 25-cycle synchronous motor.

Sideguards on each side of the mill are driven by two 50-hp motors. Manipulator fingers on the entry side are driven by two 25-hp motors.

Usual ingot sizes coming to the mill are 9-in. squares, 845 lb; 12-in. fluted squares, 1250 lb; 16½-in. fluted rounds, 2530 lb; 20½-in. fluted rounds, 4630 lb; and 22-in. round fluted, 5180 lb. In addition, continuous-cast slabs 5½ x 21½ in., 7 x 15 in. and 6½ x 24 in. are reduced on this mill.

Product from the mill consists of blooms 13 x 11 in., 10 x 7 in., 5½ x 7 in. and 4 to 8 in. square, and slabs 2¼ to 4 in. thick x 12 to 20 in. wide. The mill rolls 300 to 500 tons per 8-hr turn.

In line with the 26-in. mill and about 116 ft away is an automatic scarfing machine which can desurface all four sides of blooms or slabs. The original installation in 1943 was a conventional oxy-acetylene unit. As a result of joint research with the manufacturer of the machine, an automatic machine was developed that could use powdered iron in the flame, permitting the automatic scarfing of stainless steel. Steel is put through this machine at about 110 fpm. Oxygen pressure is about 30 psi, and 5 oz of powdered iron per min is introduced to each nozzle. A steel temperature of about 1900 F is preferred.

After cooling, the scarfed slabs and blooms are put through a shot blast unit to remove scale and slag resulting from the scarfing machine.

Also in the 26-in. mill line and 50 ft beyond the

Twelve one-way fired soaking pits heat ingots for the blooming mill. Fuel used is natural gas or fuel oil.

scarfer is a 750-ton blooming mill shear. It is driven by two 250-hp motors, and will cut hot steel up to 13 x 11 in. in cross section. Crops fall through the table into scrap buckets beneath.

BILLET MILL

A cross-transfer immediately following the 26-in. mill connects the 26-in. line with a parallel line about 22 ft away. This line contains a 22-in., 3-high stand which reduces blooms from the 26-in. mill down to billet sizes. This mill is driven direct by a 1250-hp, 50/100-rpm, 600-volt d-c motor which receives power from a 1000-kw, 600-volt d-c generator driven by a 1450-hp, 4150-volt, 750-rpm, 25-cycle synchronous motor.

The rolls are 22 in. in diam, with a 66-in. body length. They are designed with a series of grooves across the entire body. Three extra sets of housings are available which can be set up for different size schedules while the mill is rolling.

A traveling tilt table is provided on each side of the mill to handle the steel between passes and to line it up with the proper pass line in the rolls.

The 22-in. mill produces squares from 1¾ to 5 in., flats 4 to 8 in. wide and 1 to 3 in. thick, sheet bar up to 12 in. wide, rounds 3 to 8 in. in diam, hexagons and octagons of corresponding sections, and some special shapes.

Steel from the 22-in. mill may be cut to desired lengths by shear, hot saw or oxy-acetylene torch. The products are then cooled as required by metallurgical considerations. This is done in slow-cooling cradles equipped with hoods, and may require 24 to 72 hr, after which the material is moved to the billet conditioning department or annealing department.

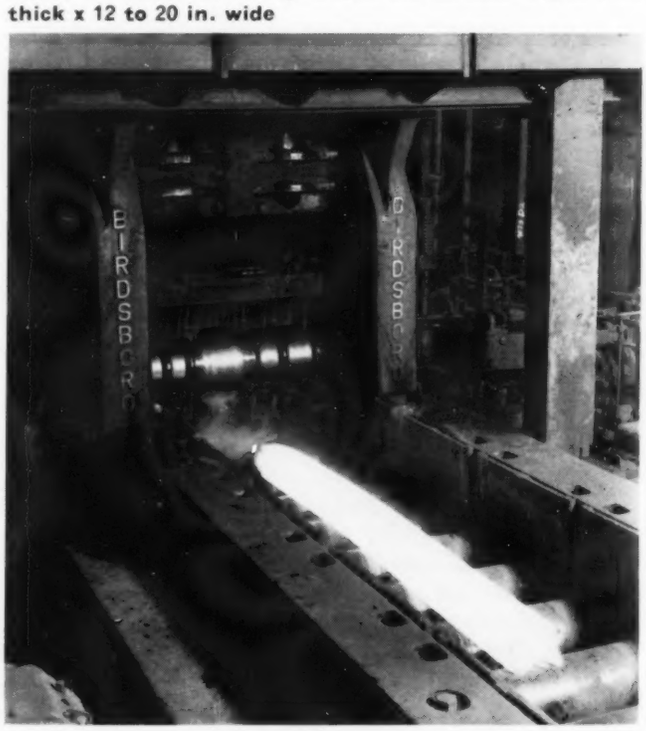
The conditioning department contains facilities for chipping low alloy grades and for grinding stainless and high alloy grades. There are also three batch tanks where some products are pickled before conditioning.

Annealing facilities here include eight car type annealing furnaces 5 ft wide and up to 30 ft long. They are fired with oil and natural gas and operate in a temperature range of 800 to 1950 F. There are also six electrically heated pit furnaces 6 ft in diam x 18 ft deep and two oil and gas-fired continuous furnaces that can take billet lengths up to 22 ft.

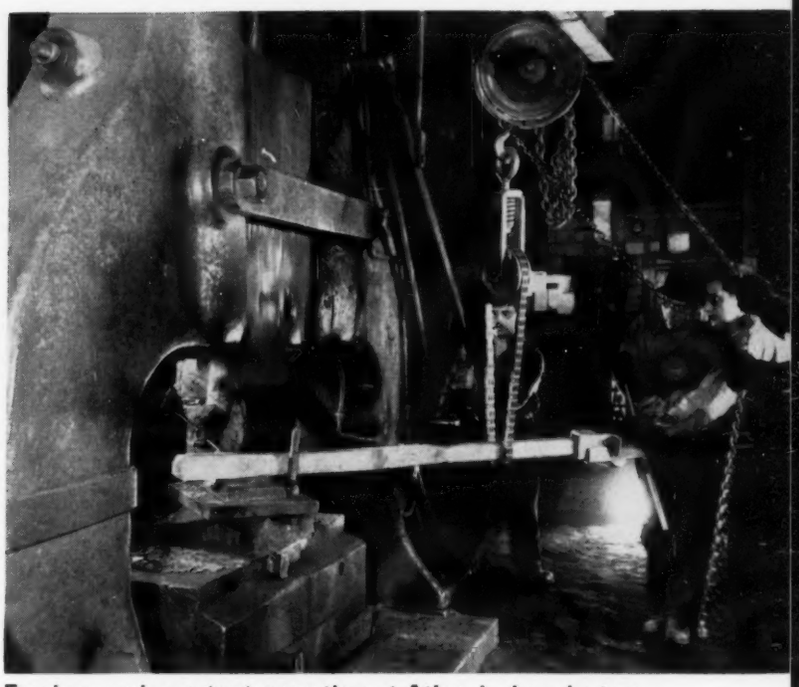
Two 300-ton hydraulic straighteners can process billets and blooms from 2¼ to 10 in. There are also five hacksaws and one automatic cutoff.

Billets which are to be made into hollow drills are pierced by 17 drilling machines capable of forming

The blooming mill is a 26-in. two-high unit, driven by a 1750-hp motor. It produces blooms 13 x 11 in., 10 x 7 in., 5½ x 7 in. and 4 to 8 in. square, as well as slabs 2¼ to 4 in. thick x 12 to 20 in. wide



The three-high 22-in. mill further reduces blooms from the 26-in. mill into 1¾ to 5-in. squares, flats 4 to 8 in. x 1 to 3 in., 3 to 8-in. rounds and other shapes of corresponding sections.



Forging, an important operation at Atlas, is done in two separate shops containing a 1200-ton press and hammers of 750 to 12,000 lb.

1 to 1⅞-in. holes 30 to 44 in. long. Steel cores are inserted in the holes and the billets are heated and rolled on the bar mill, after which the cores are withdrawn.

FORGING DEPARTMENTS

Because of the specialized nature of Atlas products, forging has always played an important part in plant operations. In one department, adjacent to the melt shop, are a 1200-ton press and a 12,000-lb hammer.

This motor-room houses the main drives of the blooming mill, billet mill and blooming mill shear, with their motor-generator sets, control equipment and switchgear.

Both are used for reducing ingots and finished forging work.

The press is of steam-hydraulic intensifier type. It has a maximum full stroke of 4 ft and a maximum power stroke of 6.64 in. The unit is served by a 20-ton crane and a 4-ton straight line manipulator with 30-in. maximum jaw opening.

Products include die blocks up to 600 sq in. cross section, finished forgings up to 19,000 lb, rounds 6 to 32 in. in diam and other heavy bar shapes. Ingots up to 52 in. and 33,000 lb are forged on the press.

The hammer, originally designed for steam operation, now operates on compressed air. It is served by a manipulator duplicating that on the press. The hammer can turn out finished forgings up to about 4000 lb.

Four furnaces, fired with natural gas or fuel oil, heat stock for the press and four smaller units serve the hammer.

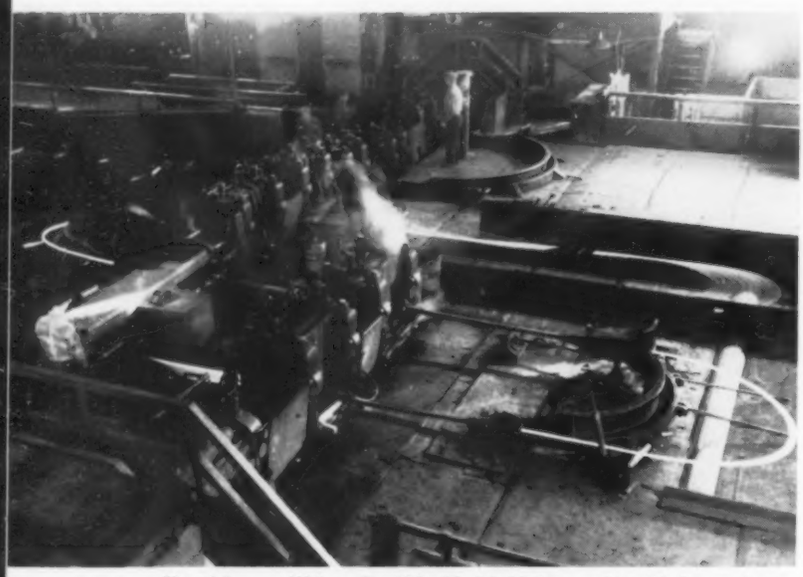
The other forging department, located in the South Plant, contains six air-operated hammers ranging from 750 to 8000 lb in size. These units perform the finish forging on small die blocks, squares, flats, hexagons, octagons, special shapes, rings, disks, hobs, etc.

Combined, the two forging departments have a nominal annual capacity of 12,000 tons.

BAR AND ROD MILLS

To produce the smaller sizes, Atlas has two bar mills. No. 1 mill is a production unit consisting of 14 or 15 stands. Billets 3 to 6 in. square are heated in an end-charge, side-discharge continuous furnace fired with natural gas or oil. It has a hearth 44 ft long x 18 ft wide.

Billets leaving the furnace pass through two 18 x 42-in. 2-high stands in tandem, driven through two combination drives and a reduction unit by a 750-hp, 4150-volt, 720-rpm induction motor. The gearing is



No. 1 bar mill is a flexible 18-16-10-in. unit which produces a wide range of rounds, squares, flats, hexagons, octagons and special shapes. Rolling rates average about 100 tons per 8-hr turn.

such as to give roll speeds of 43 rpm on the 18-in. stands.

Next are four 16-in. stands, side by side, all driven by a 1000-hp, 600-volt, 600/800-rpm d-c motor through gearing which gives roll speeds of 120/160 rpm. Three of these stands are 3-high, the fourth is 2-high. Cross-transfers move the steel from stand to stand.

Power is supplied to the 1000-hp motor by a motor-generator set consisting of a 1250-kw, 600-volt d-c generator and a 1750-hp, 4150-volt, 750-rpm, 25-cycle synchronous motor.

Further reduction may be made in two 2-high, 10 x 30-in. stands, side by side, driven direct by a 500-hp, 150/375-rpm 600-volt d-c motor. These two stands are connected by an open type repeater.

Next are five 3-high, 10-in. stands, all side by side. The first three are driven direct by an 800-hp, 150/375-rpm, 600-volt d-c motor. The last two are direct driven by a 300-hp, 200/500-rpm, 600-volt d-c motor.

In addition, a 10-in. precision stand may be placed at the outlet of 10-in. stand No. 5 when rolling precision rounds. This is driven direct by a 100-hp, 600-volt, 200/500-rpm d-c motor.

The 500-hp, 800-hp, 300-hp and 100-hp motors all draw power from a 1000-kw, 600-volt d-c generator driven at 750 rpm by a 715-hp, 4150-volt, 25-cycle synchronous motor. Open type repeaters are provided between the second and the third 10-in. stand, between the fourth and fifth 10-in. stands, and between the fifth and sixth 10-in. stands.

All roll neck bearings in No. 1 mill are composition.

This mill has three outlets. From No. 4 stand of the 16-in. train, bars from $1\frac{3}{4}$ to $2\frac{15}{16}$ in. may be delivered at a speed of about 500 fpm, proceeding on to a 150-ft hot bed. From No. 5 stand of the 10-in. group, which is in line with No. 4 stand of the 16-in. train, bars $\frac{5}{8}$ to $1\frac{11}{16}$ in. may proceed at about 800 fpm to the hot bed. From No. 7 stand of the 10-in. group, rod $\frac{1}{4}$ to $\frac{11}{16}$ in. may proceed at about 1200 fpm to either of two pouring reels. Coils may be formed weighing up to 400 lb.

When rolling bars, the first and second 10-in. stands are disconnected from their 500-hp drive, moved back into line with stands No. 3, 4 and 5, and hooked up to the 800-hp motor.

No. 1 mill rolls rounds, squares, flats, hexagons, octagons and some special shapes. Rolling rates vary widely with the product, but an over-all average is about 100 tons per 8-hr turn.

No. 2 mill is a jobbing unit. Heating for this unit is done in eight heating chambers combined into four furnaces. They are batch type, charged and drawn through doors in the front walls by a floor-type charger. Fuel is natural gas or oil.

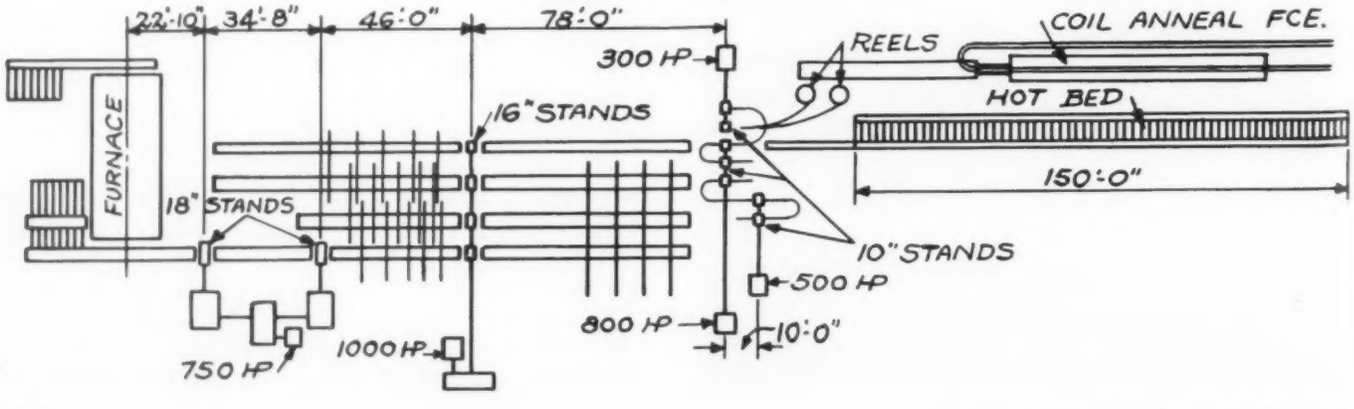
The mill consists of two 16-in. 3-high stands side-by-side, driven by a 750-hp, 720-rpm, 4150-volt, 25-cycle induction motor. A gear reduction set gives roll speeds of 87 rpm. Roll bodies are 60 in. long. Following this are four 10-in., 3-high stands and one 2-high stand, all driven through a reduction gear by an 800-hp, 400/800-rpm 600-volt d-c motor. Roll speeds are 123/246 rpm. The first three 10-in. stands have rolls of 30-in. body length, the next 24-in. body length and the last, 16-in. body length. Composition bearings are applied to all roll necks in this mill.

The 800-hp motor draws power from a 1000-kw, 600-volt d-c generator driven by a 750-hp, 4150-volt, 720-rpm, 25-cycle induction motor.

No. 2 mill has two outlets. Bars $1\frac{1}{2}$ to 6 in. are removed from the last 16-in. stand, at about 365 fpm taken over a chain transfer bed and put back through a shear and into cradles. Bars $\frac{3}{8}$ to $2\frac{1}{4}$ in. may exit at 300 to 600 fpm from No. 5 stand of the 10-in. train and proceed over a 75-ft hot-bed.

No. 2 mill usually receives billets $2\frac{1}{8}$ to 5 in. square

Layout of No. 1 bar mill.



No. 2 bar mill is a jobbing unit used principally for bars of high alloys such as tool steels, stainless, etc. Because of the specialized products, rolling rates average about 20 tons per 8-hr turn.

and reduces them to more or less the same bar sections made on No. 1 mill.

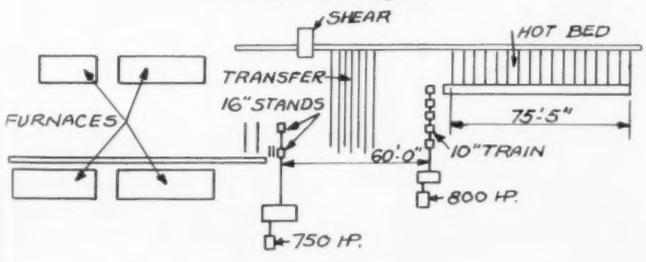
In general, No. 1 bar mill is used to roll bars of the lower alloy grades and coils of all grades. No. 2 mill is used principally for bars of the higher alloy grades, such as tool steels, stainless, etc., and because of the specialized nature of its products, its rolling rate averages about 20 tons per 8-hr turn.

Convenient to the merchant mills at the South Plant are additional finishing facilities designed to handle the products from the bar mills and the South Plant forge shop. Heat-treating and annealing is performed in oil-fired and electric car type furnaces, electric pit furnaces and semi-continuous horizontal electric furnaces.

In general, car type furnaces are used for heating prior to quenching in oil or water and for annealing, drawing and normalizing. Pit furnaces are used to anneal tool steels and any products that must be protected from decarburization. The product is packed into tubes about 12 in. in diam x 18 ft long with a mixture of sand and carbonaceous material. The tubes are charged into the pit in a vertical position.

Horizontal electrically heated furnaces heat bars up to 2 in. in diam for subsequent quenching in oil or water and for drawing.

No. 2 bar mill layout.



A separate department here heat-treats, grinds and inspects high-speed tool bits, an important product of this plant.

The South Plant finishing department also contains an extensive layout of straightening equipment, including roll straighteners, shape and flat straighteners, and gag presses.

COLD DRAW DEPARTMENT

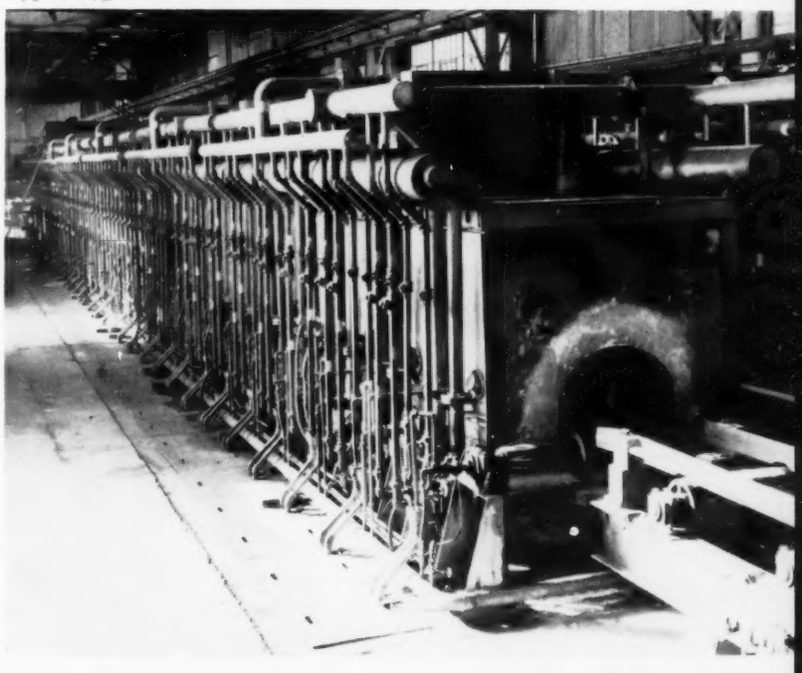
The cold draw department is located in a separate building at the north end of the plant. The department receives hot-rolled, annealed bars and hot-rolled coils from the mills. The latter are annealed in six electric pits, three gas-fired bell type furnaces or a mufflle furnace.

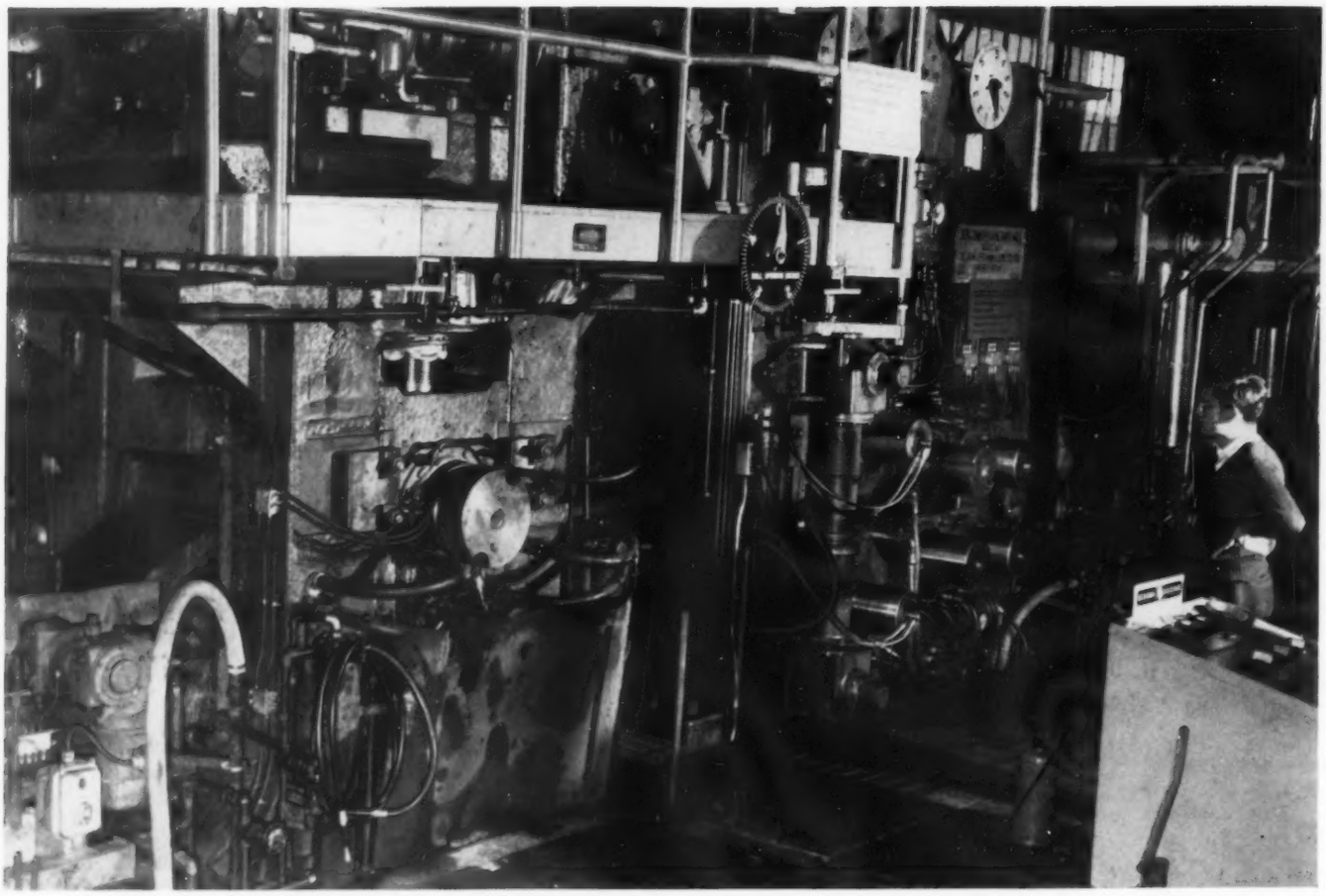
To remove all surface scale, material is next pickled in batch tanks holding sulphuric, nitric and nitric-hydrofluoric acid solutions, caustic permanganate, molten caustic, etc. Bars and coils are then washed and immersed in a hot suspension of lime, which neutralizes any remaining pickling solution, retards rusting and aids lubrication during the draw. For special finishes, the lime dip may be replaced by a light coating of copper, graphite or lead.

Bars are drawn on a 50,000-lb draw bench to diameters of ½ to 3½ in. Wire may be drawn to a size range of 0.04 to 0.64 in. on 16 single-spindle, individually driven wire drawing blocks and one continuous four-spindle machine. Reduction may vary from 5 to 35 per cent in one pass, depending on the grade of steel and the physical properties desired. If more than one pass is required to effect the specified reduction, the wire is usually given an intermediate anneal.

After being cold drawn, bars are usually put through a straightening operation. In some cases bars are rough turned or centerless ground to obtain accurate dimensions and better surface, and in some cases, to remove any decarburized layer.

Slabs for the hot strip mill are heated in a continuous, high-temperature head furnace. Slabs of stainless steel 2¼ to 2½ in. thick are heated in about 14 min.





This view of the hot strip mill shows the four necks of the feed rolls to the right, followed by the necks of the backup rolls in the planetary stand. To the right is the two-high stand.

STRIP MILL

To expand its position in the stainless market, Atlas installed a hot and cold strip mill in 1954. Here again is evidenced the company's pioneering spirit. The installation does not follow conventional lines, but has branched out to include the first planetary hot mill in North America.

Stainless slabs from the blooming mill are placed on a furnace approach table. The furnace is a continuous, high head unit through which the slabs pass, end-to-end, in a single line. The furnace is 7 ft-11½ in. wide x 7 ft-4¼ in. high x about 105 ft long and is rated at 25 tons per hr. It is fired with oil or natural gas through 120 burners, 4 burners in each of 30 chambers. Sixty burners firing on one side above the work level and sixty on the opposite side below the work set up a whirling action throughout the furnace.

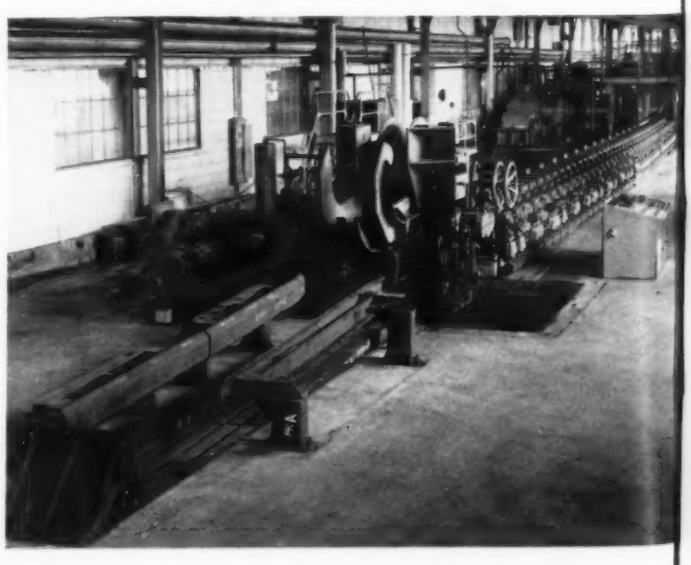
Slabs are carried through the furnace at speeds up to 11.5 fpm on water-cooled, heavy-wall seamless steel rollers 7 in. in diam.

The furnace can operate at temperatures up to 2600 F. Fuel input can reach 180,000,000 Btu per hr. Slabs of stainless steel 2¼ or 2½ in. thick are heated in about 14 min.

So as to minimize heat loss from the slab, the planetary mill stand is placed only about 11 ft from the furnace exit.

The planetary hot mill and its method of rolling strip are radical departures from usual practice. The mill consists of two large rolls 27 in. in diam x 24 in. face, each surrounded by 24 work rolls, 3⅝ in. in diam x 24 ⅛ in. face, equally spaced around the circumferences of the large rolls. The large rolls are driven in the direction of strip travel at 297.5 rpm by a 1250-hp, 2300-volt, 900-rpm 60-cycle synchronous motor. Mounted on the necks of the large rolls are cages in which the small work rolls are mounted. The assembly resembles a roller bearing without the outer race. Springs hold the work roll chocks in place in the cages so that the work rolls are held firmly against the large

This view shows the runout table leading to the three-roll upcoiler. Table rollers are individually driven by ½-hp gearmotors under adjustable voltage control.



This leveler-slitter line flattens, edge-trims and recoils hot rolled strip at speed of 75 to 300 fpm.

backup rolls. The cages revolve in the same directions as the backup rolls, carrying the work rolls with them. Actual rotation of the work rolls on their own axes, as set up by the backup roll, is in the opposite direction to that of the backup roll, and opposite to the direction of strip travel.

All four cages are linked together by synchronizing shafts and geared so that, as the cages rotate, top work rolls and bottom work rolls will always be in step, above and below the strip.

When idling, the cage assemblies are driven through a double-acting pneumatic clutch at 146 rpm by the planetary mill drive. At this cage speed, work rolls are driven at 1130 rpm by the backup rolls. When a slab enters the planetary mill, the clutch is disengaged and the cages find their proper speed for rolling, which is usually between 131 and 132 rpm.

As planetary rolls will not feed themselves, two sets of feed rolls are mounted in the same housing, just ahead of the planetary rolls. Each pair of feed rolls is driven by a 35-hp mill type motor. The feed rolls are $17\frac{3}{4}$ in. in diam x 28 in. long, and have a normal surface speed range up to 11.7 fpm.

Since the planetary mill makes a reduction of as much as 95 per cent in a single pass, the speed of the steel through the mill may jump from a typical 6 fpm on the entry side to 120 fpm or more on the exit side.

From the planetary stand, strip passes to a $22\frac{1}{2}$ x 30-in. two-high finishing stand, driven by a 250-hp, 230-volt, 420/630-rpm d-c motor. A gear reducer of 17.5 to 1 gives roll speeds of 24/36 rpm, or 142/212 fpm. The rolls in this stand are adjusted by two 10-hp motors. This stand is 9 ft-6 in. beyond the planetary stand. A looper is located between the two stands to take up slack in the strip and to regulate the finishing stand speed.

A 250-kw, 230-volt generator driven by a 400-hp, 2300-volt, 1200-rpm, 60-cycle synchronous motor supplies power to the two-high drive motor.

The strip then passes over the mill runout table to a three-roll upcoiler about 85 ft away. The coiler is driven by a 35-hp, 230-volt, 575/1150-rpm d-c motor. Runout table rollers are individually driven by gearmotors of about $\frac{1}{2}$ hp under adjustable voltage control. The coiler is served by a 50-hp motor-generator set and the runout table by two 40-hp sets, all of special characteristics.

The main drive motors, control equipment and switchgear for the hot mill are located in a motor room lying adjacent to the mill. This room is ventilated by a recirculating up-draft system with three 9300-cfm fans, three air coolers and an air filter.

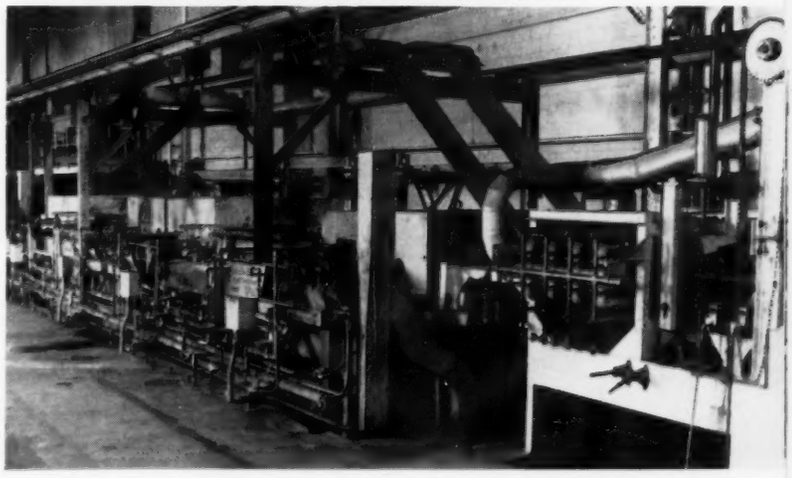
The entire hot strip mill is only about 310 ft over-all length, including the charging table, furnace, mill, runout and coiler cradle.

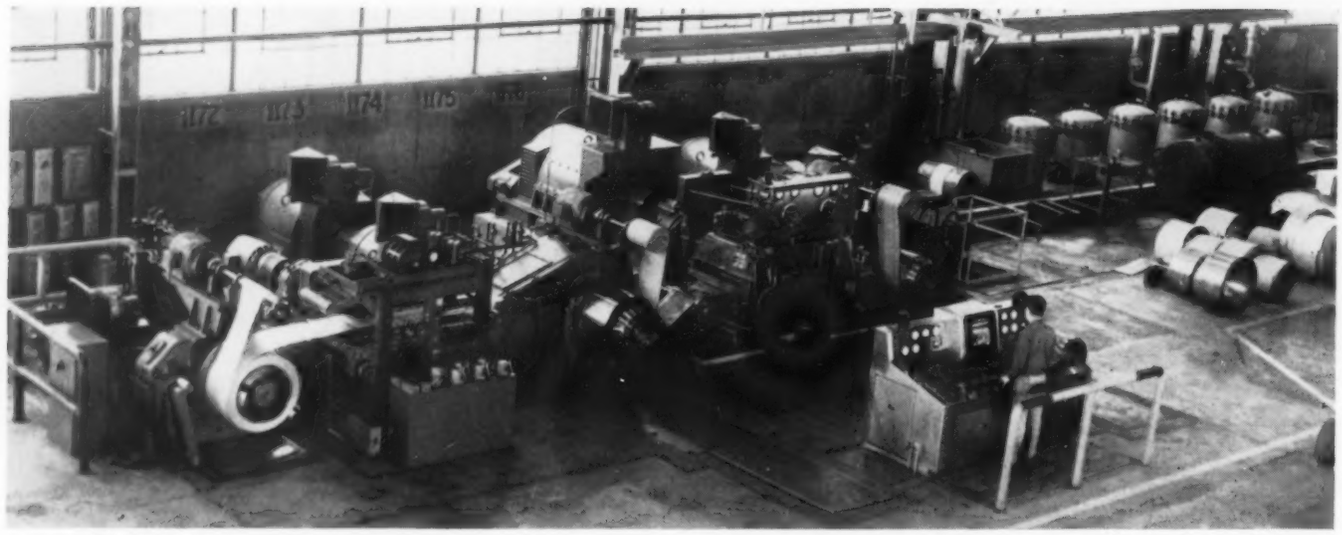
The planetary mill receives slabs ranging 12 to $20\frac{1}{2}$ in. wide, $1\frac{3}{4}$ to $2\frac{1}{2}$ in. thick, and 8 to 40 ft long. These are normally reduced to strip about 0.125 in. thick. Some slabs are reduced only to about 1 in. thickness, then cut up into sheet bar for further rolling in the hot sheet mill. The planetary mill has rolled as much as 190 tons in an 8-hr turn. It has a nominal capacity of 24,000 tons per year.

STRIP ANNEALING AND PICKLING

Hot rolled product from the planetary mill is normally put through a leveler-slitter unit, where it is flattened, edge-trimmed and recoiled at speeds of 75 to 300 fpm.

After being flattened and edge-trimmed hot rolled stainless strip is put through an annealing-pickling line. Here, the strip is by-passing the electrolytic descaling tank.





All cold reduction of strip is done by two reversing Sendzimir mills. This shows No. 2 mill, with roller leveler at the left.

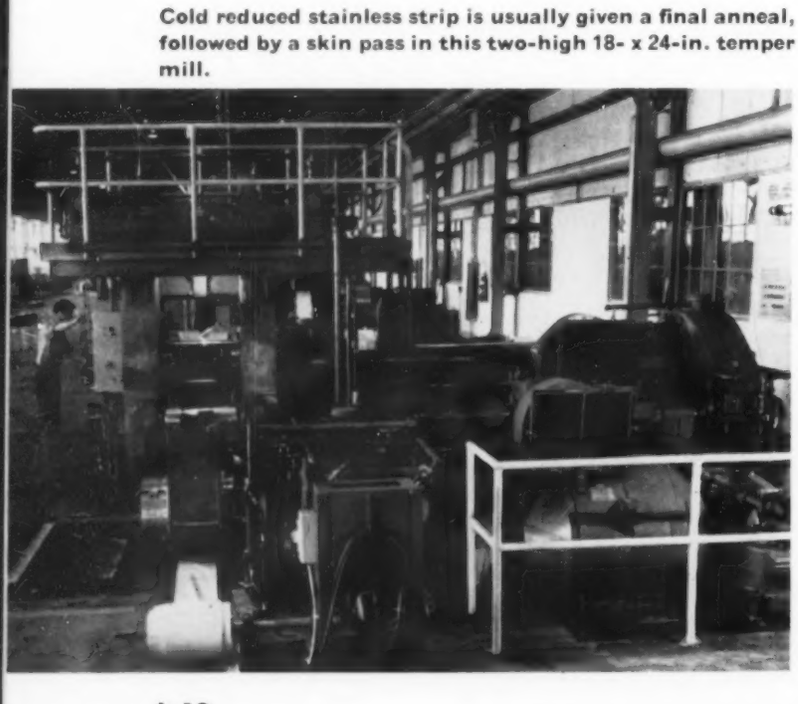
Strip is next taken to two annealing and pickling lines located in the end of the hot mill building. These lines are alike in principle, each containing uncoilers, welder, looping pit, catenary annealing furnace, quenching unit, salt descaling unit, washer, acid tanks, scrubber and dryer, inspection bench, shear and recoilers.

The two lines differ somewhat in details, with some of the pertinent details as follows:

	No. 1	*No. 2*
Over-all length, ft	500	390
Speed, fpm	4/50	8/60
Capacity, tons per day	150	60
Furnace length, ft	56	46
No. of acid tanks	3	2

Acid tanks are 32 to 38 ft long, about 7 ft wide, and 3 ft-3 in. deep. Each tank holds 2800 to 3000 gal of pickling solution. They are of welded steel construction, lined with rubber and carbon brick. Their covers are vented through ducts to the atmosphere.

Cold reduced stainless strip is usually given a final anneal, followed by a skin pass in this two-high 18- x 24-in. temper mill.



Electrolytic apparatus is provided for the salt descale and the second acid tank on No. 1 line, and for the first acid tank on No. 2 line. The solutions in all tanks may be heated to the desired temperatures by steam under automatic control.

The salt bath consists of molten sodium hydroxide, maintained at a temperature of 900 F. Pickling solutions may be of sulphuric acid, nitric acid or a nitric-hydrofluoric mixture, hot or cold. Strip may be put through any or all of the treatments in these lines, as desired. This is important, as the lines are used for hot rolled and cold rolled materials of varying analyses.

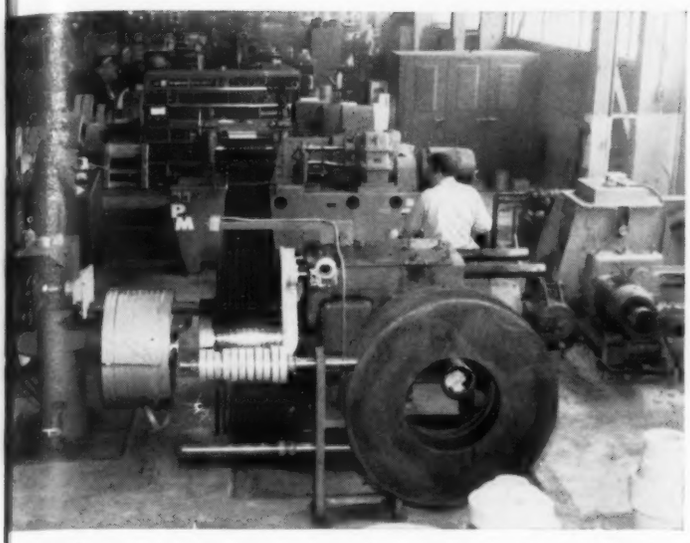
In either furnace, two strands of strip can be processed simultaneously, each strand independently controlled. The strip ranges 0.007 to 0.187 in. in thickness and 10 to 20 in. in width.

COLD STRIP MILLS

Unless destined to be sold as hot rolled, pickled material, coils are ready for cold rolling. Two reversing Sendzimir mills are provided for this purpose. In these units, work rolls $1\frac{9}{16}$ in. in diam are backed by pairs of intermediate rolls $2\frac{13}{16}$ in. in diam, each of which is in turn backed by a pair of 5-in. rolls. The 5-in. rolls are again backed by larger segmented rolls—actually, rows of 8-in. outside diameter bearings on common shafts. The intermediate rolls are driven, while the outer segmented rolls provide the rolling pressure.

From the uncoiling reel, the strip passes through a roller leveler, through the mill, and on to the exit tension reel, where the front end of the coil is gripped. The work rolls are brought together and the strip is reduced and recoiled. It is rolled back and forth under controlled tension. The draft and number of passes depend on the final gage desired and on the grade of material being rolled.

No. 1 mill, rated at 1800 tons per month, handles strip 0.01 to 0.187 in. in thickness up to $18\frac{1}{2}$ in. wide. It is driven by a 300-hp, 600/1000-rpm, 250-volt d-c motor. Each reel is driven by a 200-hp, 300/1200-rpm, 250-volt motor. Rolling speeds range up to 500 fpm maximum. This mill is powered by a motor-gen-



Finished coils may be cut to desired widths in this slitting unit. This unit is also used to slit strip to close tolerances for use in the tube mill.

erator set made up of a 300-kw, 250-volt d-c generator for the mill, two 200-kw, 250-volt generators for the reels, and an 800-hp, 2300-volt, 1200-rpm, 60-cycle synchronous motor.

No. 2 mill is rated at 600 tons per month and handles strip 0.002 to 0.08 in. thick in widths up to 18½ in. This mill is driven by a 350-hp, 300/600-rpm, 250-volt d-c motor. Each reel is driven by a 200-hp, 230-volt motor and a 100-hp, 115-volt motor, both 300/1200 rpm, connected in series and mounted in tandem. Rolling speed may go as high as 800 fpm. No. 2 mill is served by a motor-generator set consisting of a 300-kw, 250-volt d-c generator for the mill drive, and two 250-kw, 350-volt generators for the reels, all driven by a 700-hp, 2300-volt, 1200-rpm, 60-cycle synchronous motor.

X-ray gages give the operator strip thickness measurements accurate to 0.0001 in.

Strip can be reduced in a number of passes by as much as 90 per cent. Each pass, however, hardens the steel. Hence, in rolling to thin gages, it is generally necessary to return coils to the annealing-pickling lines for intermediate annealing.

Product is usually given a final anneal after cold rolling, and a temper or skin pass is normally then required to flatten the strip and bring it to the desired stiffness. This is performed by a two-high 18 x 24-in. stand driven by a 150-hp, 450/900-rpm, 230-volt d-c motor. Two 100-hp, 300/1200-rpm, 250-volt d-c motors drive the reels. A motor-generator set composed of a 200-kw, 250-volt d-c generator for the mill drive, two 125-kw, 250-volt generators for the reel drives and a 400-hp, 2300-volt, 1200-rip 60-cycle synchronous motor supplies the mill.

The finished coils may be put through a side-trimming and slitting unit, where they can be cut to desired widths. This line, consisting of an uncoiler, a slitter, a scrap baller and a recoiler, operates at speeds up to 300 fpm. It is capable of handling cold rolled strip 0.007 to 0.083 in. thick up to 20 in. wide. This unit is also used to slit strip to close tolerances for use in the tube mill.

If the material is desired in cut lengths rather than in coiled form, coils are taken to a leveling-shearing line which can make up to 18 cuts per min on stainless strip 0.01 to 0.15 in. thick up to 20 in. wide, cutting lengths of 2 to 10 ft.

TUBE MILL

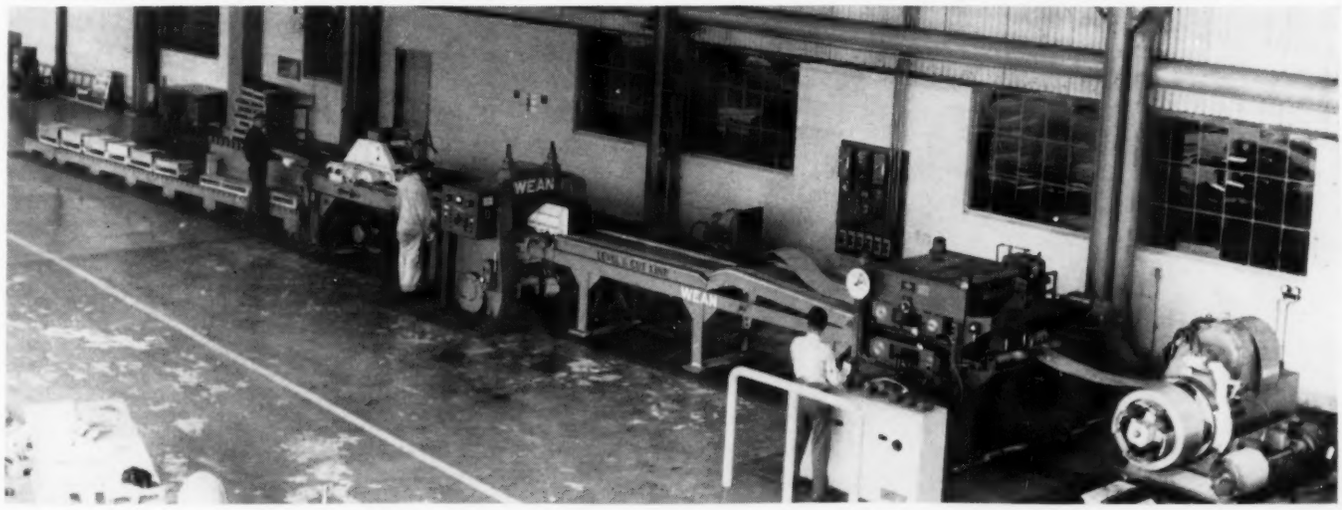
An important part of Atlas' recent expansion is a cold-formed electric weld tube mill.

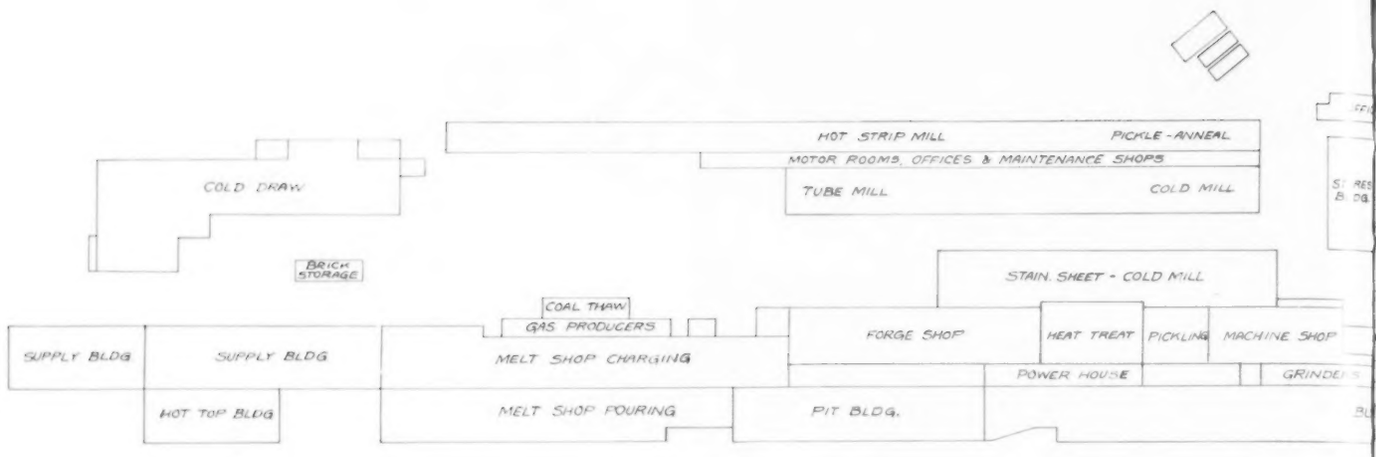
Material to be made into tubes comes in coils accurately slit to width on the cold slitting line. A coil is placed on the uncoiler and threaded through the mill, which consists of six horizontal forming stands, four vertical forming stands and a set of vertical welding rolls. These stands form the strip until its edges meet and the seam closed. An automatic electric arc welding machine joins the edges under a blanket of helium. No welding rod is used.

The tube mill is driven by a 20-hp, 440-volt, 900-rpm, 60-cycle induction motor.

The welded tube passes through a water spray, then into three horizontal and two vertical sizing stands, which true the tube form. A flying saw cuts the tube automatically to desired lengths.

This leveling-shearing line cuts coils of strip 0.01 to 0.15 in. thick and up to 20 in. wide into cut lengths of 2 to 10 ft.





Tubes ½ in. and smaller are immersed in water and tested at 250 psi for leakage. They are then degreased in trichloroethylene and given a bright anneal in an atmosphere of cracked ammonia. Finally, the tubes are cold drawn over a mandrel, increasing length and reducing diameter and wall thickness. Intermediate degreasing and bright annealing may be necessary if the cold draw reductions are heavy.

Finally, tubes are straightened, cut to finished lengths and given a final test and inspection.

Large tubes are handled in the same way except that they are annealed in a large conventional furnace and then pickled.

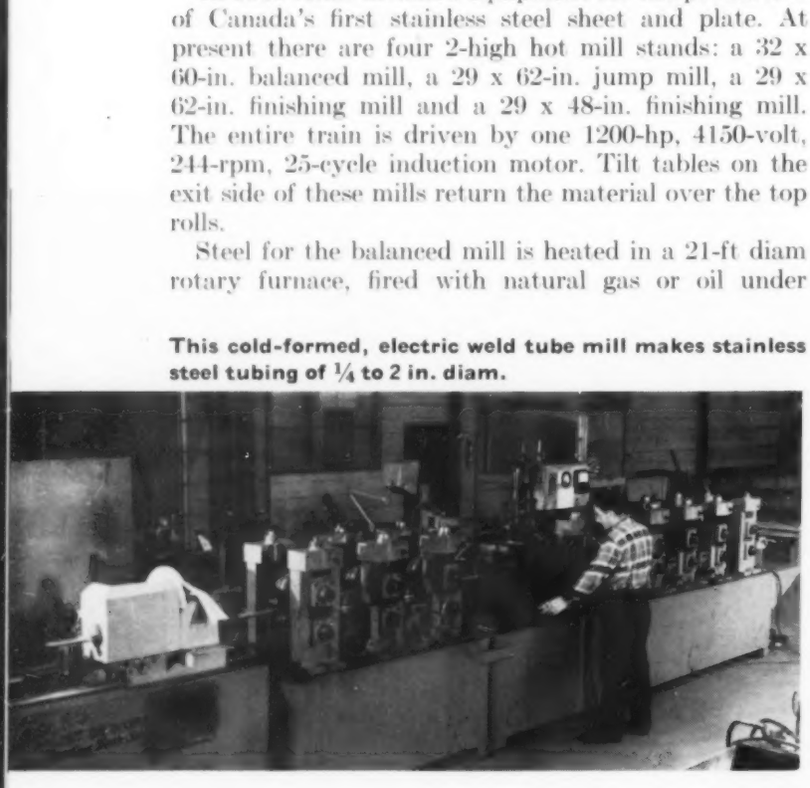
Tubes may be given various finishes to meet customer requirements. Finished tubes range from ¼ to 2 in. in diam. The department is rated at an annual capacity of 200 tons of stainless tubing.

SHEET MILL

In 1950 Atlas installed equipment for the production of Canada's first stainless steel sheet and plate. At present there are four 2-high hot mill stands: a 32 x 60-in. balanced mill, a 29 x 62-in. jump mill, a 29 x 62-in. finishing mill and a 29 x 48-in. finishing mill. The entire train is driven by one 1200-hp, 4150-volt, 244-rpm, 25-cycle induction motor. Tilt tables on the exit side of these mills return the material over the top rolls.

Steel for the balanced mill is heated in a 21-ft diam rotary furnace, fired with natural gas or oil under automatic temperature control. Two batch-type furnaces heat for the jump mill. The finishing mills are served by five gas-fired batch furnaces.

This cold-formed, electric weld tube mill makes stainless steel tubing of ¼ to 2 in. diam.



Bars to be reduced in the sheet mill usually run about 19 in. wide, 1 to 4 in. thick, and 39 to 51 in. long. They are cut to the desired lengths from long slabs which were rolled on the blooming mill either from ingots or continuous cast slabs.

All product 0.25 in. thick or heavier is rolled directly to size on the balanced mill. For thinner product, this mill breaks the bars down to 0.25 in. They are then sheared as required, reheated and rolled into finished sheet on the finishing mills. Two shears are provided in the hot mill, one a 96-in. unit capable of cutting stainless up to ⅝ in. thick, the other a 156-in. unit capable of cutting up to 0.2 in. thickness.

Hot rolled product is annealed in an open gas-fired roller hearth furnace, passing through on water-cooled alloy rolls with silicon carbide sleeves. Leaving the furnace, the material may be quenched by water, steam or air blast and racked up for pickling.

Pickling is performed in a series of batch operations closely resembling the process carried on in the continuous strip pickling lines. First is a dip in a 16 x 20-ft salt pot holding 80 tons of molten sodium hydroxide. Next is a water quench, immersion in a heated 12 per cent sulphuric acid solution, a water rinse, immersion in a heated nitric-hydrofluoric acid solution (12 per cent nitric, 2 per cent hydrofluoric by volume), rinsing and washing, and finally, scrubbing and drying.

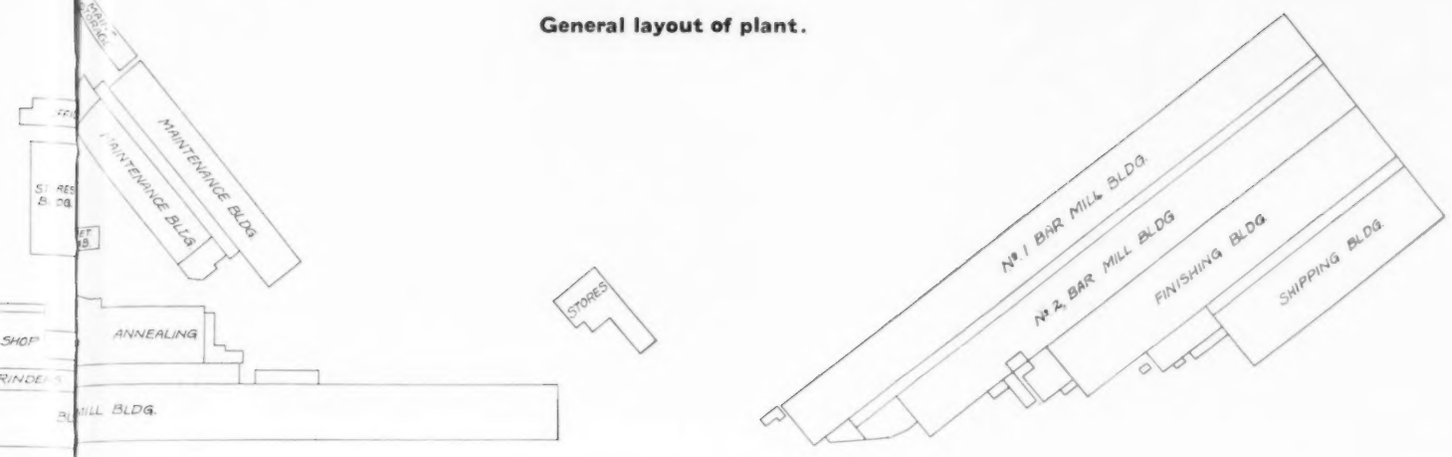
Some pickled product is merely flattened and shipped. Some goes on to further processing.

A 60-in. Sendzimir cold mill performs the cold reduction. It is driven by a 500-hp, 250-volt, 600/900-rpm d-c motor and is capable of making a 20 per cent reduction on No. 16 gage sheets in five or six passes. Minimum thickness is No. 22 gage. Rolling speeds may range as high as 60 fpm. Sheets are handled into and out of the mill by mechanical devices equipped with vacuum cups. This equipment can be operated automatically or manually.

The 500-hp drive motor receives power from a 500-kw, 250-volt d-c generator driven at 750 rpm by a 715-hp, 4150-volt, 25-cycle synchronous motor.

After cold reduction, product is again annealed and pickled, and may then be skin passed through a 26 x 60-in. two-high jump mill.

General layout of plant.



Other equipment in the cold mill includes a 250-ton stretcher leveler, a 500-ton stretcher leveler, a 54-in. roller leveler, three belt type polishing machines, a 156 x 0.187-in. shear and a 144 x 0.25-in. shear.

The sheet mill produces sheet and plate in a number of stainless grades, as well as some super alloys, tool steels, and titanium and zirconium alloys. The common finishes are No. 1 (hot rolled, annealed, pickled and flattened), No. 2 D (hot rolled, annealed, pickled, cold rolled, annealed, pickled and flattened), No. 2 B (hot rolled, annealed, pickled, cold rolled, annealed, pickled, temper rolled and flattened), and No. 4 (hot rolled, annealed, pickled, ground with 50, 80 and 120 grit, and polished. From No. 16 gage down, the sheet is cold reduced).

QUALITY CONTROL

As might be expected from the highly specialized nature of Atlas products, extreme care must be exercised in their manufacture. To insure a high degree of quality, the chemical, metallurgical and inspection departments act as watch-dogs at all important steps in the processes.

An important function of the chemical laboratory is the routine melting furnace control to help the melter hit the desired analysis. A direct-reading spectrometer, capable of analyzing for up to 12 elements per sample in a minute and a half, performs more than half of the 40,000 analyses made each month.

The laboratory also checks the composition of incoming scrap, checks analyses of billet samples to confirm ladle analyses, performs special analyses required by development work and metallurgical service, and checks the quality of various supplies.

Through a staff of metallurgists, observers and technicians, the metallurgical department scrutinizes all phases of plant operation. A central laboratory is equipped with complete facilities for conventional testing and for special investigations. Each heat of steel is evaluated before it proceeds into production, and the type of tests conducted depends on the grade of the steel and its application.

Depending on the product, the tests may include various combinations from the following: mechanical properties, soundness, cleanliness, tensile, toughness, hardness, hardenability, creep, behavior at elevated temperatures, structure, grain size, decarburization, fatigue and machinability.

The major part of the metallurgical testing is done at the central laboratory. Special laboratories, however, are set up at the cold draw department and the strip and tube departments. Here technicians carry out routine forms of hardness, etch, bend and tensile testing.

Through the various phases of production, processing standards have been set up, outlining manufacturing procedures.

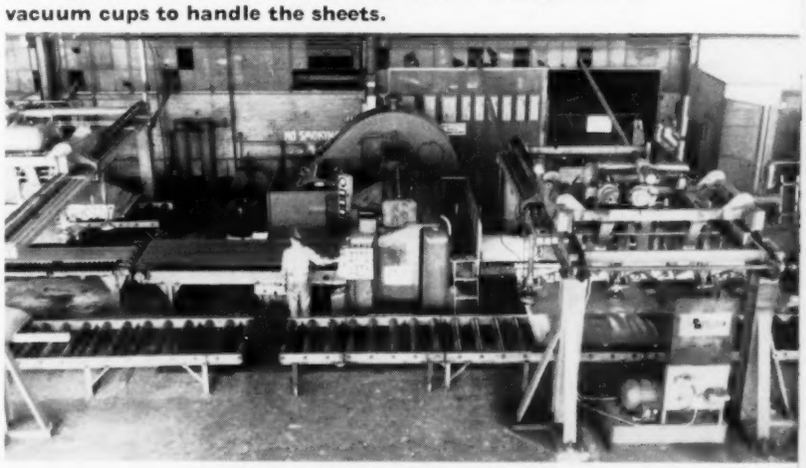
The inspection department is primarily concerned with the physical aspects of quality, such as dimensions, shape, surface, etc. Its activities center around the conditioning department, cold draw department, sheet mill, strip and tube mill and at the South plant where all rolled and forged bars, forgings, rings, disks and die blocks pass.

At the conditioning department, all blooms, slabs and billets are examined and surface defects are marked for removal by scarfing, chipping or grinding. The material is again examined after conditioning.

At the cold draw department, the final inspection looks at size, shape, length, straightness, quality of surface finish and freedom from surface defects.

At the sheet mill, the first inspection, made after pickling, looks primarily at size and freedom from surface defects. The final inspection is made at the finishing shears, where sheets are checked for size,

Sheets are cold rolled in this 60-in. Sendzimir mill. At the right is shown the mechanical device equipped with vacuum cups to handle the sheets.



length, width, flatness, surface finish and quality of shearing.

Strip is likewise inspected as it leaves the pickling lines, and again at the shearing line. Tubing is examined for size, wall thickness, length, surface finish and freedom from defects.

UTILITIES AND SERVICES

All power is purchased from the Hydro Electric Power Commission of Ontario at both 60 and 25 cycles. The more recent 60-cycle load is supplied at 27,600 volts and is stepped down to 2300 volts at two load centers: a 5000-kva station serving the strip and tube mills, and a 2500-kva station supplying the continuous casting facilities, induction furnaces, swing-frame grinders, sheet polishers, etc.

The older 25-cycle power is transmitted at 110,000 volts and stepped down to 26,400 volts by two 25,000-kva transformers in the utility's sub-station. Power for the four newest arc furnaces goes directly to the melt shop at 26,400 volts. Power for the two oldest furnaces and for the general plant load is reduced to 4150 volts by two 3000-kva transformers for the furnaces and a 9000-kva bank at a separate substation.

The electric furnaces set up a 10-min demand of about 32,000 kw and the rest of the plant has a 10-min demand of about 11,000 kw. Recording meters on the 25-cycle system (exclusive of the melt shop) and the 60-cycle system are transmitted to a totalizing meter which is under constant observation by a dispatcher. If the existing peak demand is threatened, the dispatcher orders operations curtailed wherever it is most advantageous. Total power consumption is approximately 13,000,000 kwhr per month.

Steam for heating and process work is generated by three water-tube boilers at 160-psi pressure, 430 F total temperature. Two boilers are rated at 380 hp, one at 500 hp. One of the 380-hp units operates on waste heat from the soaking pits, or on gas or oil. The other two boilers use stoker-fired coal.

Service water consumption averages 9,000,000 to 10,000,000 gal per day. It is pumped from the Welland Canal by five pumps with a total capacity of 12,500 gpm. One of these is operated by a gasoline engine and another has a diesel auxiliary drive. Two 20-in. mains connect the pump house to the steel plant. Pure water is purchased from the city of Welland.

With normal operations, the plant uses about 5,300,000 cu ft of natural gas per day. This comes principally from Western Canada and is distributed in the plant at 15-psi pressure. A control system is used to dispatch natural gas, wherein all large consumers (about 95 per cent of the total consumption) are telemetered to a central control room. The dispatcher's board indicates what fuel each department is using. The dispatcher communicates by direct wire to the large consumers and can control consumption in accordance with contract provisions. The same man also dispatches electric power, as previously mentioned.

Fuel oil is obtained mainly from Canadian refineries. It is brought down the Welland Canal in lake tankers and unloaded into a 2,250,000-gal tank, from which a pipeline runs to the steel plant. At the plant, another tank of 2,750,000-gal capacity offers additional storage.

The attractive, well-planned administration building of Atlas Steels uses stainless steel curtain walls.

Since the oil used is No. 2 grade, no heating or recirculating system is necessary. As oil is used principally as stand-by, monthly consumption may run as little as 5000 gal.

Oxygen is purchased from an outside supplier and piped three miles to the plant. It is used for carbon elimination in the electric furnaces and for scarfing, flame cutting, welding, etc. Monthly use averages about 3,750,000 cu ft.

Acetylene is generated from carbide in four generators each having a capacity of 2000 cu ft per hr. The gas is piped around the plant at 14½ psi pressure. It is used for scarfing, cutting, welding, etc.

Compressed air is produced by seven compressors having a combined capacity of 13,000 cfm of free air. It is distributed around the plant at 90 psi pressure.

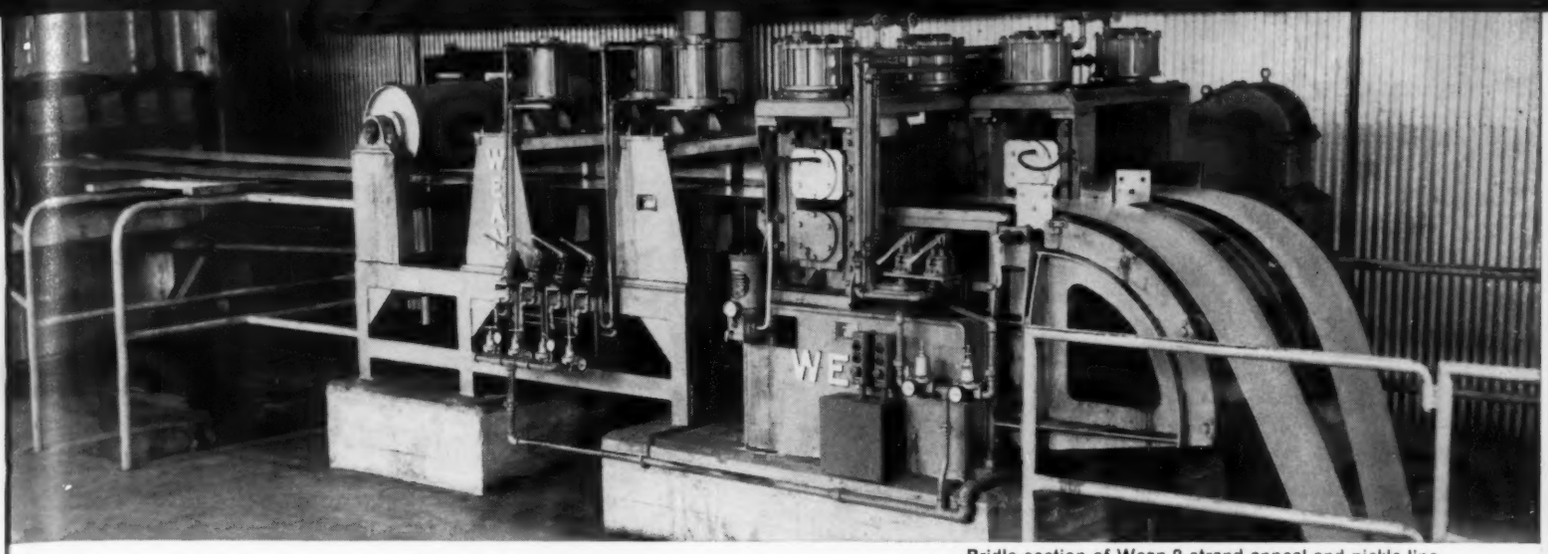
Area maintenance is carried on by millwrights, electricians, pipefitters and oilers assigned to the operating units, Major repairs and shopwork are performed by centralized crews of skilled tradesmen. The central maintenance building houses carpenter, pipe, millwright, electric, rigger, welding, paint, bricklayer and instrument repair shops. Machine shop facilities are centered in a shop that was formerly a production unit particularly adapted to heavy turning and boring. It is still used to machine forgings for customers when required, but also handles all machine work for maintenance.

Work is assigned to these trades groups by a planning and scheduling unit located at maintenance headquarters. Control over the inventory of a large stock of spare parts is also centered in this unit.

Transportation within the plant is carried on by rail and truck. Three diesel locomotives (70, 30 and 10-ton) and 35 cars operate on approximately six miles of standard gage track. A narrow-gage fireless locomotive operates on the melt floor. Seven trucks, six tractors, 15 industrial trucks, one diesel-electric crane, one steam crane and a trackless boom crane complete the ground transport.

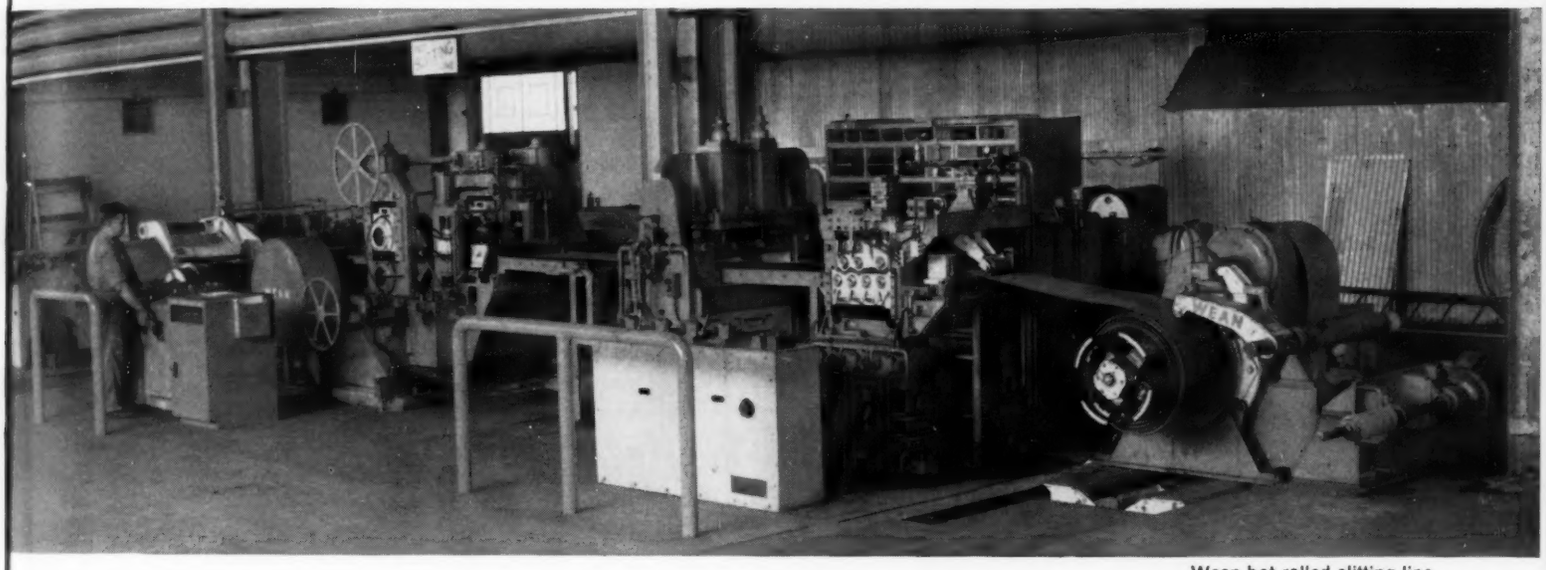
* * * * *

In its relatively short span, Atlas has helped build the economy of Canada in peace and war. It has helped build the community of Welland, through stable employment for many families. It has benefited its stockholders who had faith in the enterprise. It has fulfilled the dream of its founder—and it looks forward to the future with confidence. ▲



Bridle section of Wean 2-strand anneal and pickle line

At ATLAS STEELS, LTD. Welland, Ontario



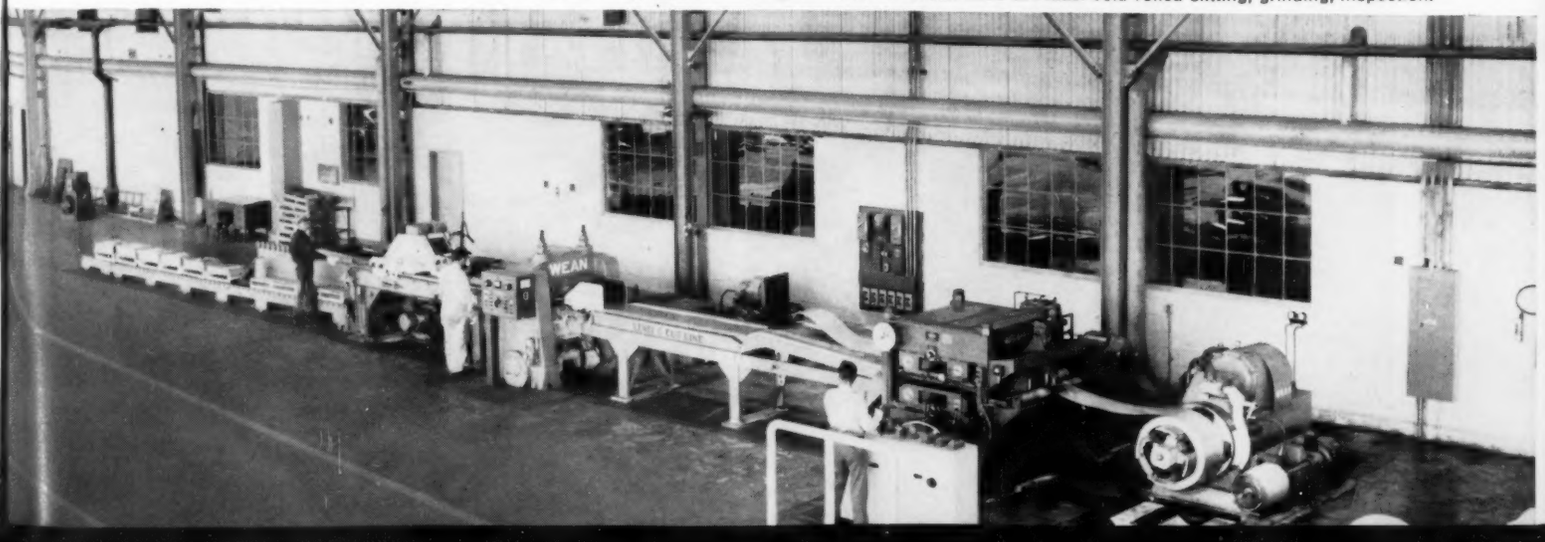
Wean hot-rolled slitting line

complete stainless strip
processing facilities
were designed and built by

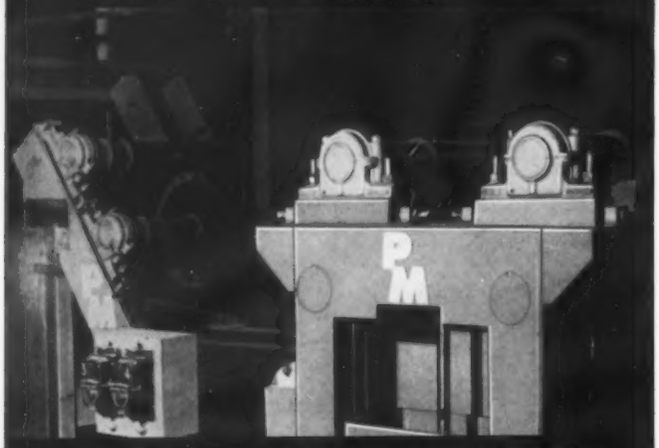
WEAN EQUIPMENT CORPORATION
CLEVELAND, OHIO: Offices in Chicago • Detroit • Newark

WEAN

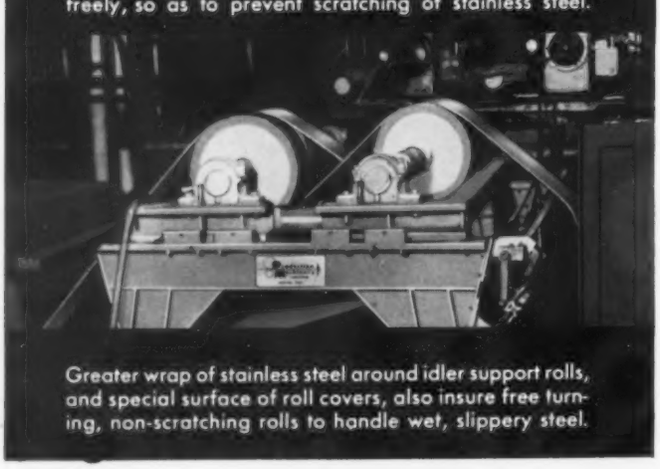
Wean loop-table cut-to-length line. Other Wean lines at Atlas: cold-rolled slitting, grinding, inspection.



Finish end of new PM 2-strand pickle line that improves output, quality for stainless steel producer. (Note evenness of coils on PM coilers.)



Separate, independent rolls for each strand have shafts mounted in anti-friction bearings outside pickle tanks away from corrosive fumes. This permits rolls to turn freely, so as to prevent scratching of stainless steel.



Greater wrap of stainless steel around idler support rolls, and special surface of roll covers, also insure free turning, non-scratching rolls to handle wet, slippery steel.

PM's "PRODUCTIONEERED EQUIPMENT"

For Atlas includes: Finish Pickle Line

- **Vacuum Handling Equipment**
- **Inspection Line**
- **Slitter**

As an example of what PM "productioneered equipment" can do for you, take one feature of the PM stainless steel annealing and pickling line for Atlas illustrated at left.*

Previously, support rolls on continuous pickling lines processing stainless steel tended to mar the surface of the metal. Marks were produced when the idler rolls failed to turn as fast as the strip passing over them.

Because PM designers *understood* this problem, they were able to design this new pickle line with special bearings, provision for more wrap of steel around the rolls, special surface on the rubber covering, and other design details which insure that rolls turn at strip speed, thus eliminating scratching of the stainless steel.

This and additional design refinements such as automatic strip tracking devices make this line capable of more usable output, with greater uniformity in product quality, and less trouble for operators.

In addition to the pickle line, PM's productioneered equipment furnished to Atlas includes vacuum handling equipment, an inspection line, and light gauge slitter precisely tailored to requirements.

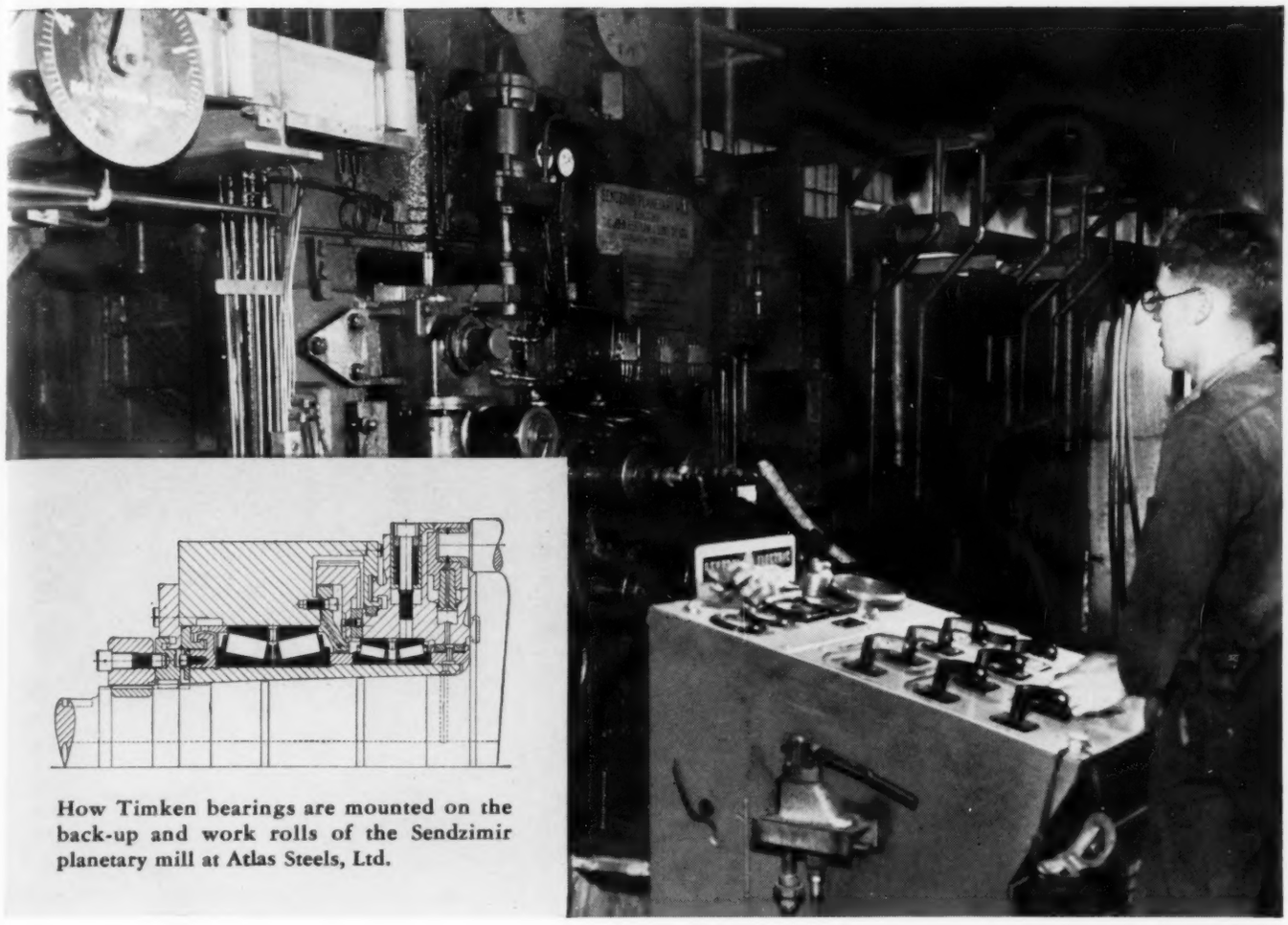
This PM way of attacking problems can solve tough equipment problems for you, too. Call in a PM man as soon as you start planning installation of any of the metal processing equipment listed below.

Production Machinery Corporation

Mentor, Ohio

*PRODUCTIONEERED EQUIPMENT results from the P/M way of working so engineers who supervise equipment design have first-hand knowledge of problems encountered by sheet and strip processing line users. In working with P/M, you work with responsible engineers who apply their skill to solve your problems.

Pickling lines • slit coil banding equipment • slitting lines • shearing and cut-to-length lines • grinding and scouring lines • coil build-up and inspection lines • vacuum handling equipment • continuous lines for annealing, coating, grit-blast cleaning, and miscellaneous Sheet and Strip Processing.



How Timken bearings are mounted on the back-up and work rolls of the Sendzimir planetary mill at Atlas Steels, Ltd.

Unique mill reduces slabs from 2¼" to ⅛" thickness in one pass . . . Timken® bearings take the shock

THE only machine of its kind in production in North America, this Sendzimir Planetary Hot Rolling Mill at Atlas Steels, Ltd., Welland, Ontario, makes only one pass to reduce slabs from 2¼" thick x 20" maximum width to ⅛" thick x 20" wide. Based on a new concept of rolling hot strip, it required many mechanical features not found in conventional mills. And to take the heavy shocks, keep bearing cost down, feed rolls, work roll cages, and back-up rolls are mounted on Timken® tapered roller bearings.

1008 mills of all types throughout the world depend on Timken bearings for economical operation. Here's why:

1) *Balanced Proportion Design* of Timken bearings provides the optimum combination of bearing capacity, rigidity and roll neck strength. Load ratings are increased up to 40%. And their tapered design enables Timken bearings to take both radial and thrust loads.

2) *Longer life.* Tonnage records show that the long life of Timken roll neck bearings keeps bearing cost per ton of steel rolled to a bare minimum.

3) *Closer, more uniform gauge* in products rolled because Timken bearings positively locate mill rolls. And the low starting friction gives better product finish, cuts scrap losses, and results in higher mill speed.

4) *Economical lubrication* Timken bearings permit simple grease lubrication and operate efficiently with the new oil mist systems.

For better new or existing rolling mill equipment, specify Timken tapered roller bearings. They help machines do better work. That's BETTER-ness. And its symbol is the trade-mark "TIMKEN". Look for it. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable: "TIMROSCO". *Makers of Tapered Roller Bearings, Fine Alloy Steels and Removable Rock Bits.*

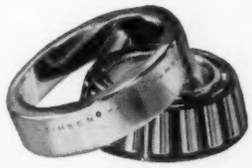
This symbol on a product means its bearings are the best.

WHEN YOU BUY TIMKEN® BEARINGS YOU GET...

1. Quality you can take for granted
2. Service you can't get anywhere else
3. The best-known name in bearings
4. The pace setter in lower bearing costs

BETTER-NESS rolls on

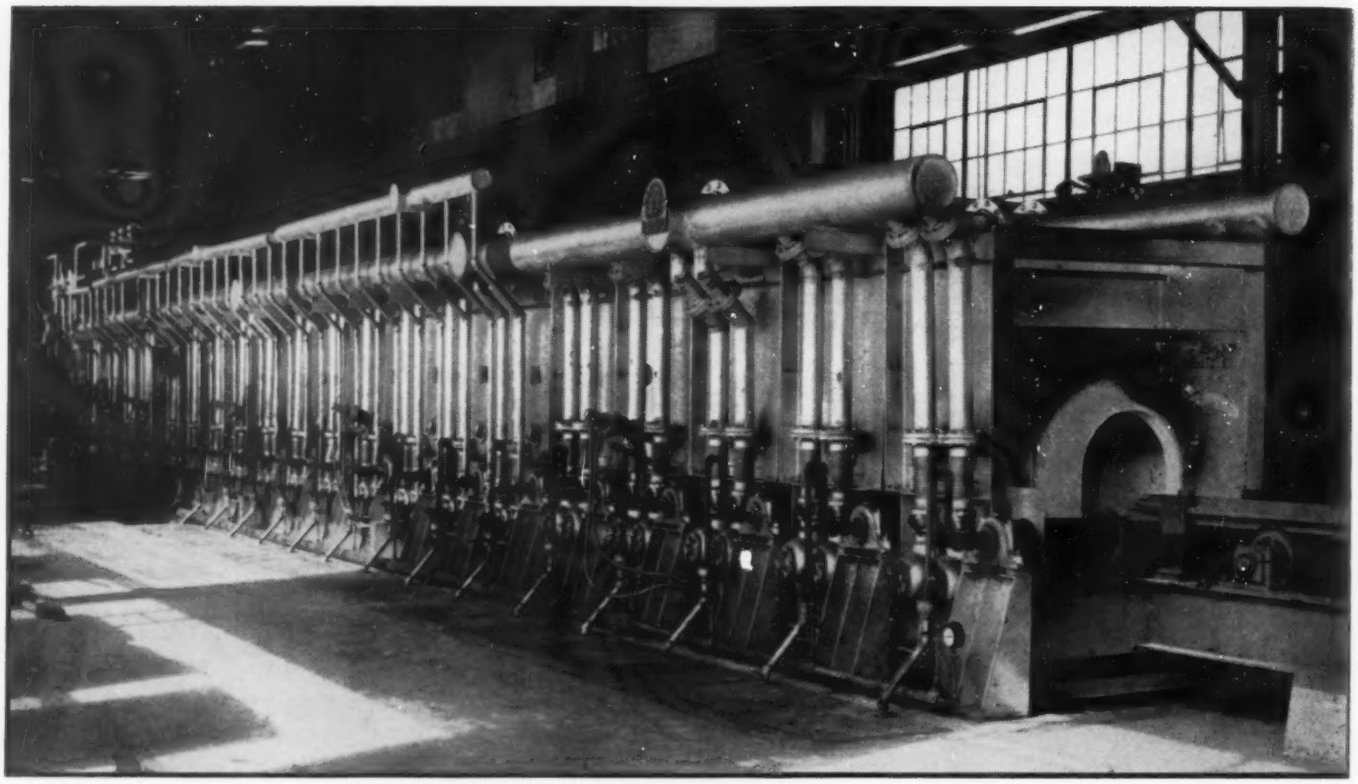
TIMKEN®



First in bearings for 60 years

tapered roller bearings

SPEED HEATING . . . SAVE SPACE . . . IMPROVE QUALITY with HI-HEAD



R-S HI-HEAD HEATS 25 TONS SLAB PER HOUR . . . 75% LESS FLOOR SPACE . . . ONE FOURTH LABOR

Now, heating of 25 tons of stainless steel slabs per hour is a continuous operation at Atlas Steels Ltd. The R-S Hi-Head Furnace reaches a high heat fast and maintains it uniformly in all parts of the furnace for the complete cycle. Heating time is reduced . . . there is no overheating of slab edges . . . and uniformity is assured on every piece. Labor is one-fourth that required on conventional furnaces. Floor space is 75% less.

You can boost your "Quality Quota" if you heat with R-S Furnaces. For full technical details on faster slab heating write for the folder "Continuous Slab Heating."

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North Wales, Pa.

Telephone OXbow 9-4853

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Check all SUTTON Processing Machines

for better production

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Seven Roll, Five Roll and Two Roll for
Cold Drawn Bars
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STRAIGHTENING PRESSES

SHAPE STRAIGHTENERS for Hexagons, Flats, Rounds, Squares, Structural and Extruded Shapes

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PRECISION ROLLER LEVELLERS for Aluminum Sheets, Steel Sheets and Coil Processing Lines

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Horizontal or Vertical for Aluminum, Steel, Brass, Lead and other Modern Metals

HYDRAULIC STRETCH-STRAIGHTENERS for Sheets, Bars, Extruded Shapes

HYDRAULIC PRESS STRAIGHTENERS

ROLLS, UNIVERSAL JOINTS

Ask for specific data about the equipment you need

SUTTON
Engineering Company
First National Bank Bldg.
Pittsburgh 22, Pa.

SUTTON STRAIGHTENERS
with *Syncro-Drive*
for bars and tubes of all metals

A complete new series of 5-ROLL, ROTARY STRAIGHTENERS

For Superior Straightening at High Production Speeds

Patented Sutton Syncro-Drive provides entirely guideless, precision straightening for the finest quality end-to-end straightness of bar and tube stock.

With Syncro-Drive, users can straighten materials previously found difficult, or even impossible to straighten, such as thin-walled tubes and bars of stainless steel, brass, zirconium, titanium and other modern metals.

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Model 15SD
(PICTURED)

For Bars
from 5/16" to 2" Dia.

For Tubes
from 5/16" to 3" O.D.

8 MACHINE SIZES AVAILABLE FOR BARS AND TUBES OF ALL SIZES

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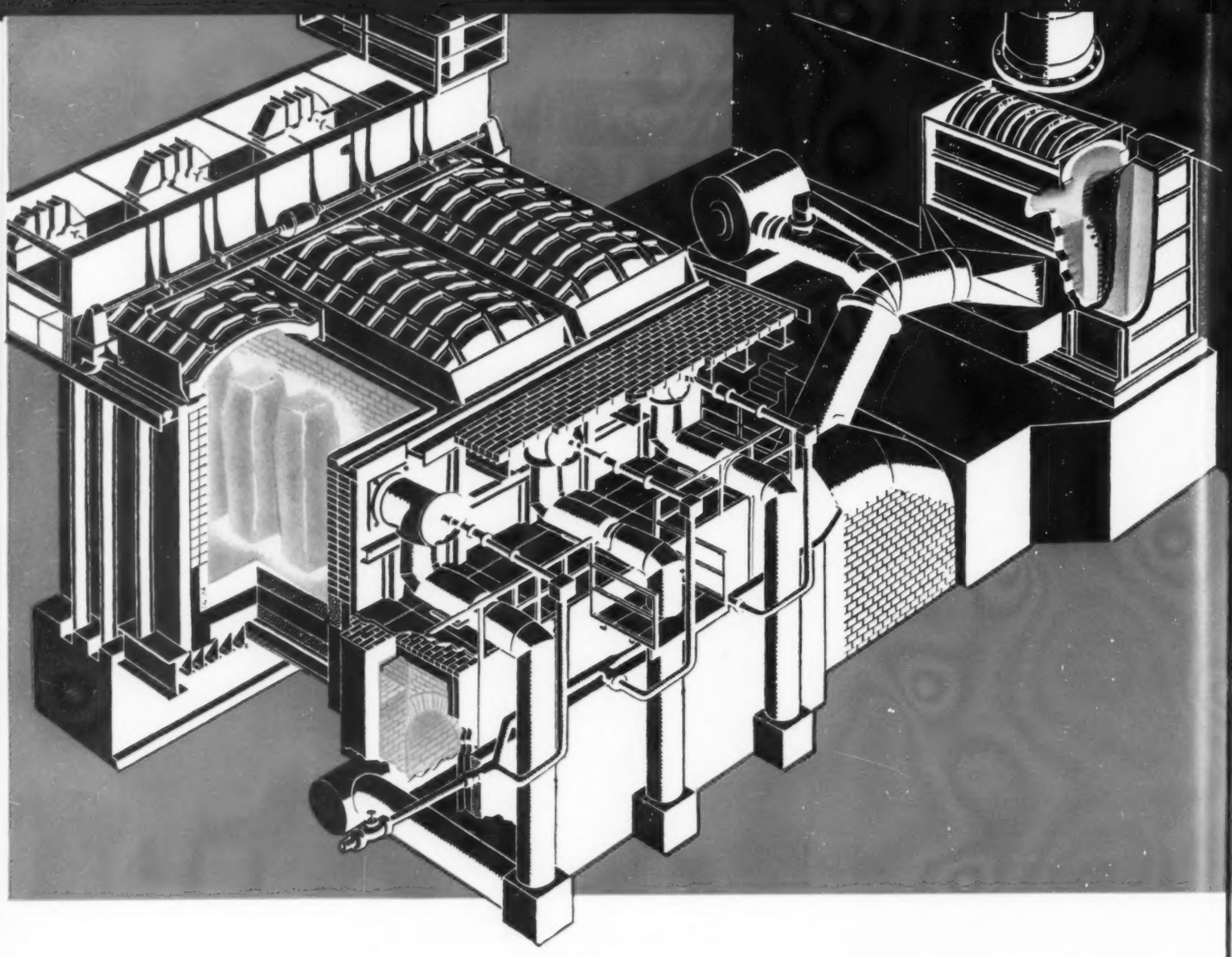
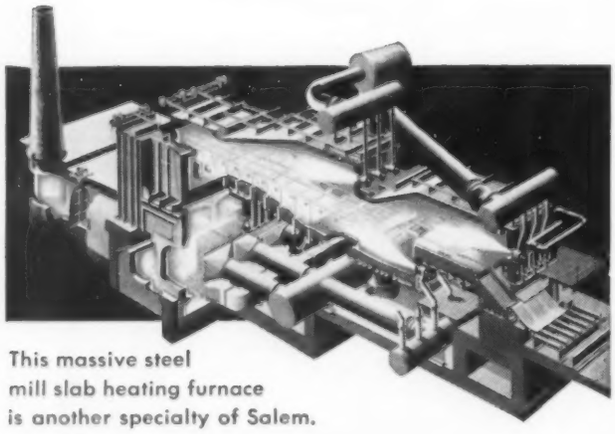
Manufacturers of Straighteners, Hydraulic Extrusion Presses, Centerless Bar Turners, Rotary Swagers, Sheet Levellers and other Processing Machines for Modern Metals.



Ingot Heating is Fast and Uniform in Salem Soaking Pits



This massive steel mill slab heating furnace is another specialty of Salem.

This cutaway picture of a three-hold battery of soaking pit furnaces is typical of installations designed and erected by the Salem organization throughout the world. These pits condition ingots for further processing and work around-the-clock to produce more uniformly heated steel products at lower cost. Salem-Brosius engineers are specialists in performance and control of heat in manufacturing, offering furnaces custom-built to your requirements. Salem furnaces assure you maximum high quality output at minimum initial, operating and service costs.

If your modernization or expansion plans call for heating or heat treating furnaces of any kind, furnace charging or forging manipulation equipment, valves or hot material handling machinery, write, wire or phone.

SALEM ENGINEERING LIMITED

555 DIXON ROAD, REXDALE, TORONTO, ONT.

a subsidiary of *SALEM-BROSIUS, INC.*, Pittsburgh, Pa.

Salem Engineering Co. Ltd., Milford, Eng.
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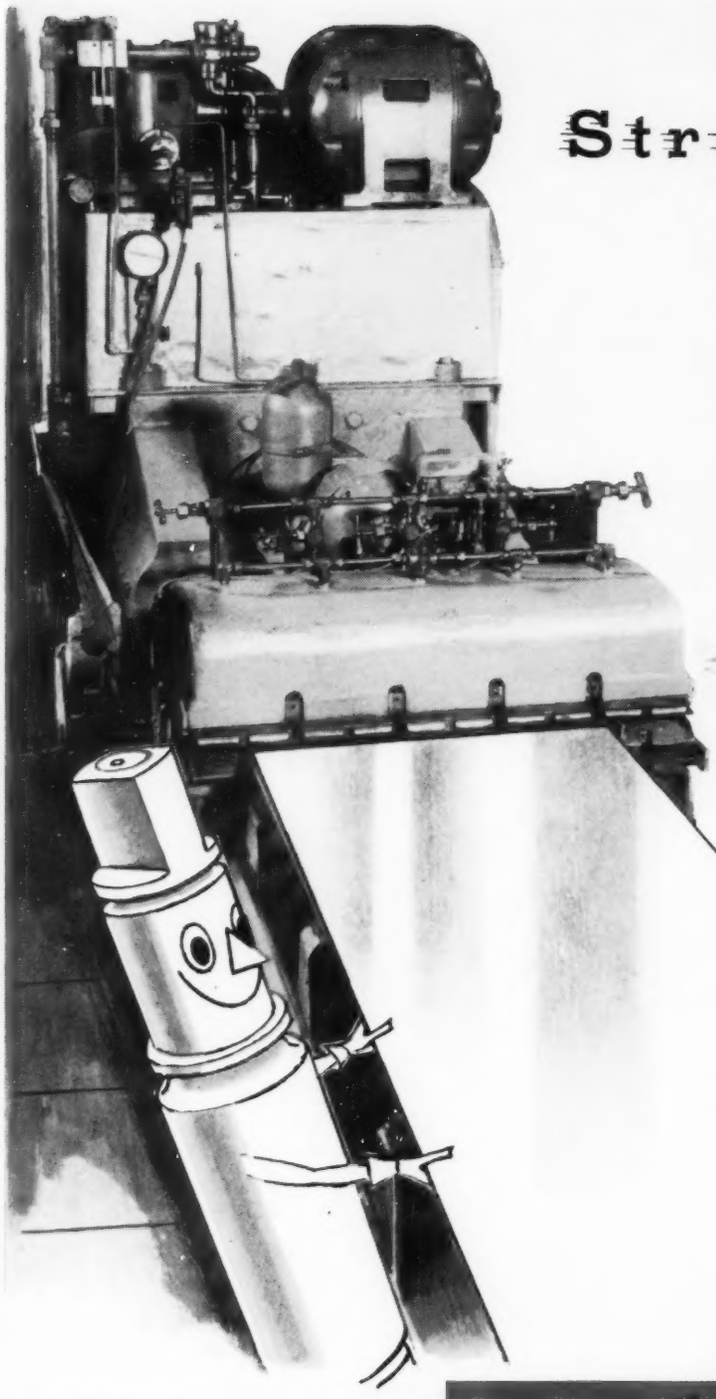
Salem-Brosius, S.A., Paris, France
Alloy Manufacturing Corp., Pittsburgh, Pa.

Hyde Park
Stretcher LEVELLERS

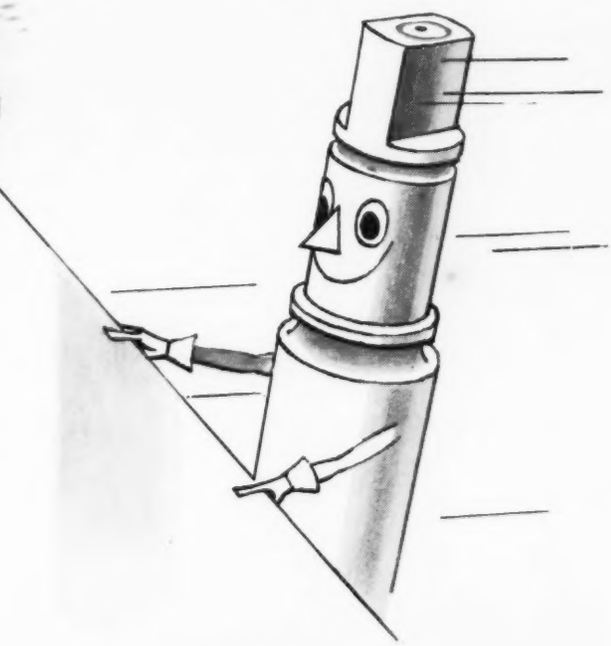


Designed and built for dependability and super-performance, Hyde Park Sheet Stretcher Levellers have maintained a record for high service for over fifty years.

Complete range of stretching capacities from 150 to 1250 tons for levelling ferrous and non-ferrous sheets up to 120″ wide x 500″ long. Speeds and length of "stretch" to meet all requirements.

Pneumatically or hydraulically operated wedge or toggle type jaws. Adaptable for automatic cycling.

Our engineers will be glad to cooperate with you in the production of special equipment.



Photograph showing Hyde Park 500 Ton Leveller Installation at Atlas Steels, Limited, Welland, Ontario, Canada.

ROLLS

Nickel Alloy Grain Rolls	Nickel Chilled Rolls
Grain Rolls	Moly Rolls
Chilled Rolls	Nodular Iron Rolls

All Grades Nickel Alloy Iron Rolls for Hot and Cold Rolling

ROLLING MILL EQUIPMENT

Bar Mills	Sheet and Strip Mills
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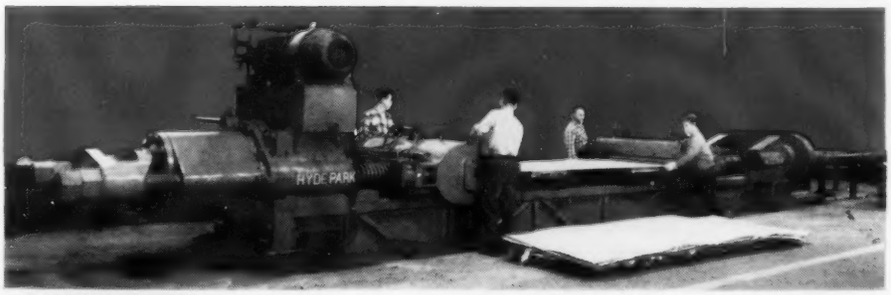
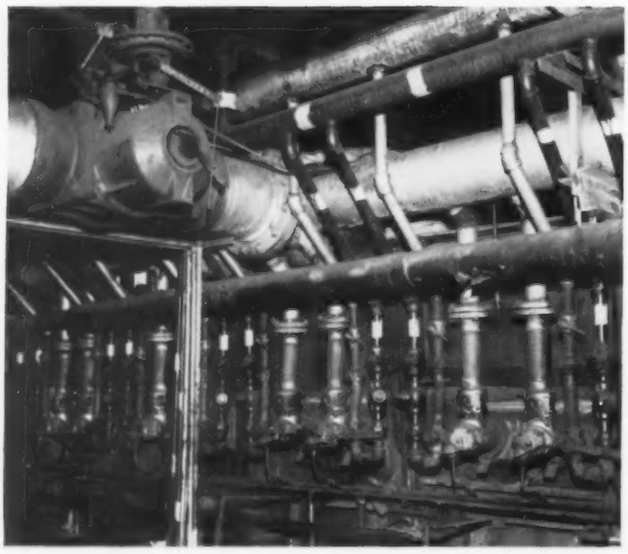


Hyde Park

RED CIRCLE Rolls ALLOY-CHILLED

FOUNDRY and MACHINE CO.

HYDE PARK, WESTMORELAND COUNTY, PITTSBURGH DISTRICT, PA.



Atlas Steels Limited's Utilities Engineer says: "Maintenance is confined to the water-cooled rolls and the refractory. This furnace has proven that special and complex heating equipment is not required to obtain very high thermal releases in a small space."

This high thermal head furnace heats 2¼"x 20" stainless steel slabs for one-step reduction to ⅛" in a planetary rolling mill. Slabs pass through the 108 ft., 7 zone furnace in only 14 minutes including soak time.

The elliptical combustion chamber is fired tangentially with 2 rows of North American Series 221 Dual-Fuel Burners. N. A. Adjustable Port Valves and #600 Air Motors Control the input.

You too can save money—specify North American burners, blowers, and controls—they're built for high production without high maintenance.

For engineering information,
call your nearby North American Combustion Engineer or write to ▼

NORTH AMERICAN for COMBUSTION and Hydraulic Controls

The North American Mfg. Co.
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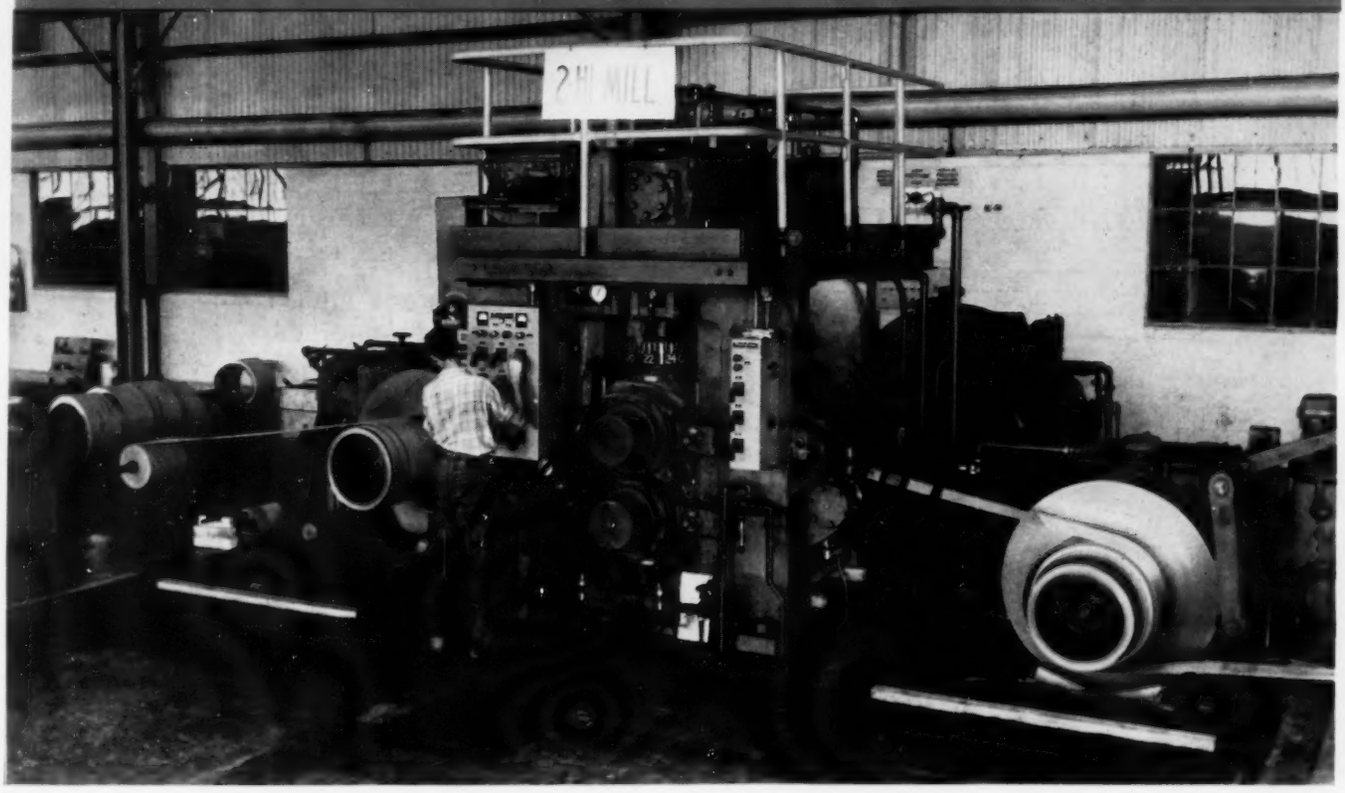
TREADWELL TEMPERING MILLS

(complete with coiling equipment)

Commended for performance by Atlas Steels *



**"Tempering mills that do a dependable, efficient job day in and day out" says Atlas Steels limited.*

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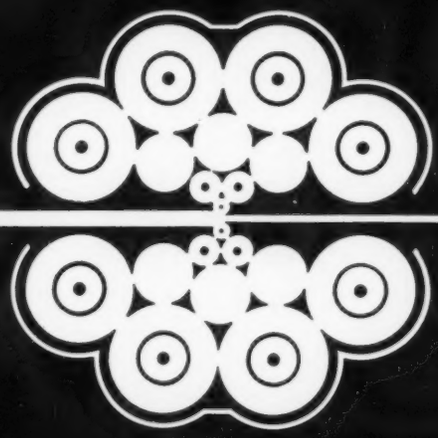

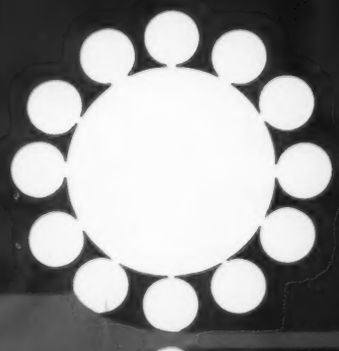

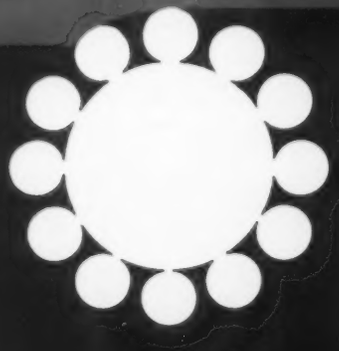

PLANETARY MILLS

T. SENDZIMIR, INC.

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Superex is easily combined with other insulations such as Johns-Manville Thermobestos®, J-M 85% Magnesia or J-M Insulating Fire Brick.

After a quarter century . . .

there's still no substitute for J-M Superex insulation for service to 1900F!

In many ways, Superex® is the finest block insulation yet developed for high temperature furnace applications!

Made of diatomaceous silica and asbestos, Superex offers exceptional heat resistance—excellent insulating value. And at high temperature its stability is unsurpassed: it combines low shrinkage with excellent thermal effectiveness . . . easily withstands the physical abuse encountered in normal service.

Superex also speeds and simplifies installation. *Easy-to-handle*—Superex weighs only 2 lbs. per sq. ft. per inch thickness. *Strong*—it compresses only ⅛ inch under 6 tons' pressure per square ft. Superex is available in a wide variety of shapes and sizes . . . is easily cut with an ordinary knife or saw.

For further information write to Johns-Manville, Box 14, New York 16, N. Y. In Canada, Port Credit, Ontario.

For medium temperature applications, specify J-M Superex M blocks . . . for temperatures to 1600F.

Saves waste. Superex comes in 7 standard thicknesses from 1" to 4". Other sizes available on order.

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Johns-Manville INSULATIONS *FOR LASTING THERMAL EFFICIENCY*

MATERIALS • ENGINEERING • APPLICATION

Stuart

Productive Lubrication

how Stuart metalworking lubricants upgraded production at Atlas Steels Limited

Flexible E.P. oil meets 3-way lubrication test to increase output of Sendzimir rolling mill

Stuart's Rol-Kleen #6 boosts bearing life 50%, reduces downtime

A single E.P. lubricant, Stuart's Rol-Kleen #6, solved a tough quality control and maintenance problem on this Sendzimir cold sheet rolling mill at Atlas Steels Limited, Welland, Ontario.

The bearing oil formerly used could not stand up under the extreme pressure of the lubricating system. This caused excessive bearing wear, tying up production while bearings were replaced. In addition, Atlas was experiencing a high incidence of staining because on a Sendzimir the lubricating oil functions also as a rolling oil.

Rol-Kleen's extreme pressure additive and high lubricity meets the 3-way test of "productive lubrication" at Atlas. It withstands the high pressures of the lubrication system. It increases bearing life (about 50% in this case) and reduces maintenance downtime. There is no longer a staining problem—so quality of aircraft super-alloy steel and stainless sheets can be controlled.

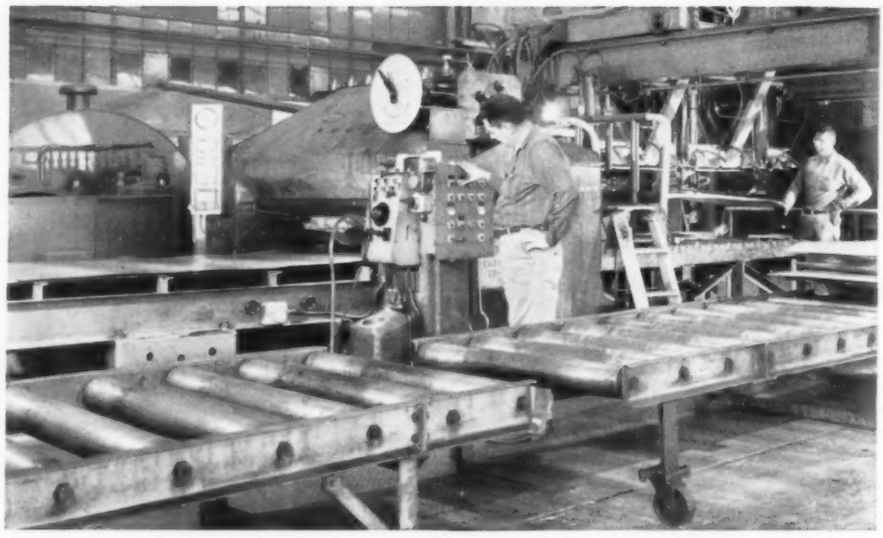
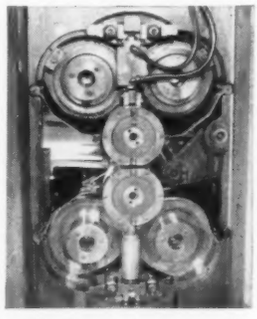


Fig. 1—Mill efficiency was increased by Stuart's Rol-Kleen #6, pumped from a central 1700-gal. tank which supplies lubricant for bearings and work rolls.

Fig. 2—Atlas turns out 2B and 2D finishes, as well as light gauge #4, using an E.P. type lubricant for rolling as well as machine lubrication.

Dual-purpose lubrication

The selection of a lubricant for a Sendzimir mill is especially critical since both the machine and roll lubrication systems are supplied by the same 1700-gal. central system. The oil is fed to the work by the flood-type roll feed lubricator. A monel screen and bag-type filtering system reclaims oil not carried off by the work.



Rol-Kleen prevents metal-to-metal contact in the 14 main bearings along the top of each roll and 7 bearings at the bottom, and no bearing failures have occurred as a result of friction during the three years Rol-Kleen has been used in the mill.

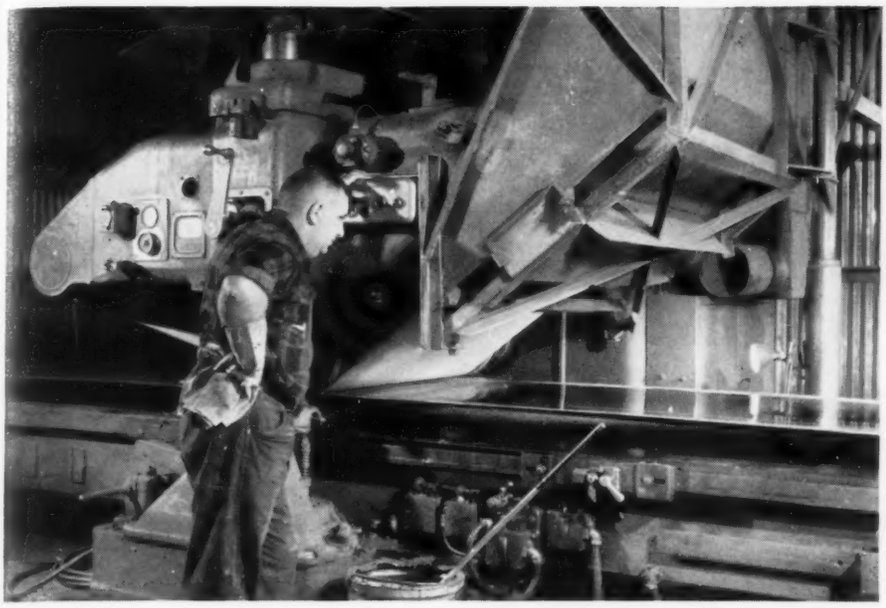


Fig. 1—Belt life was increased 25% and production in the roughing operation doubled when Stuart's ThredKut 99 replaced a complex 3-oil lubrication system on this Mattison abrasive belt grinding and polishing machine. Combination of high sulphur activity and lubricity helps control uniformity of surface finish, an important factor in producing stainless for matched panels used in construction and assembly. Considerably fewer flash fires have been experienced during four years ThredKut 99 has been used on the job, with cutting speeds averaging 3600 sfpm. This is due not only to the higher flash point of the lubricant, but mainly to the fact that less heat is generated under the positive, free-cutting action of ThredKut 99.

General-purpose lubricant jumps production 200%, belt life 25%...grinding stainless to #4 finish

Complex 3-oil system eliminated by Stuart's flexible ThredKut 99 for abrasive belt grinding and polishing

There may be an idea here for you in the way Atlas Steels Limited uses Stuart's ThredKut 99 for all four steps in the processing of stainless steel sheet.

This general-purpose lubricant combines high chemical activity for free cutting of tough, non-pickled stainless, with extra lubricity needed for producing high surface finishes. It is used with belts ranging from 50 grit for roughing to 120 and 150 grit for finishing.

With the introduction of ThredKut 99 to replace three different lubricants formerly used, production in the roughing cycle quickly doubled.

Belt life has increased 25%, permitting important reductions in both machine downtime and belt inventory costs. The job has been simplified and the possibility of operator mistakes and spoilage is reduced now that ThredKut 99 supplies all of the qualities required for optimum stock removal and scratch pattern in the roughing, intermediate grinding, finishing and polishing cycles.

This is an important benefit to Atlas customers who desire to match stainless panels placed side by side in construction or assembly.

Danger of flash fires greatly reduced

The higher flash point of ThredKut 99 has been one of the contributing factors in practically eliminating flash fires formerly experienced on this operation. With cutting speeds averaging 3600 sfpm, positive, free-cutting action of ThredKut 99 reduces the amount of heat generated. Viscosity of the lubricant is 190 sec at 100° F, assuring excellent belt penetration and "wetting" of the grains. Thus, rapid cooling is provided by the grinding fluid, in addition to inherent cooling advantages of the grinder. (The 243" long belt cools longer between revolutions of the contact roll, and flexing action provided by the four rolls helps the belt "break loose.")

Fig. 2—ThredKut 99 is easily applied to the work with a soft bristle brush. Formerly, three special oils were used on four different phases of the grinding and polishing cycle.

Stuart

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Atlas Steels' *26" 2-high reversing blooming mill*

speeds production under the **BIRDSBORO** *trademark*

And that trademark has come to mean quite a lot to steel producers in the U.S., Canada, Europe and other points on the globe. The strength and ruggedness demanded by the steel industry are blended with the advanced thinking and modern design ideas of the BIRDSBORO engineers. The result is productive and profitable mill machinery with a long, useful service life. The BIRDSBORO representative in your area can cite specifics. You'll find them very interesting. *Sales Department, Engineering Department and Plant:* Birdsboro, Pa., *District Office:* Pittsburgh, Pa.

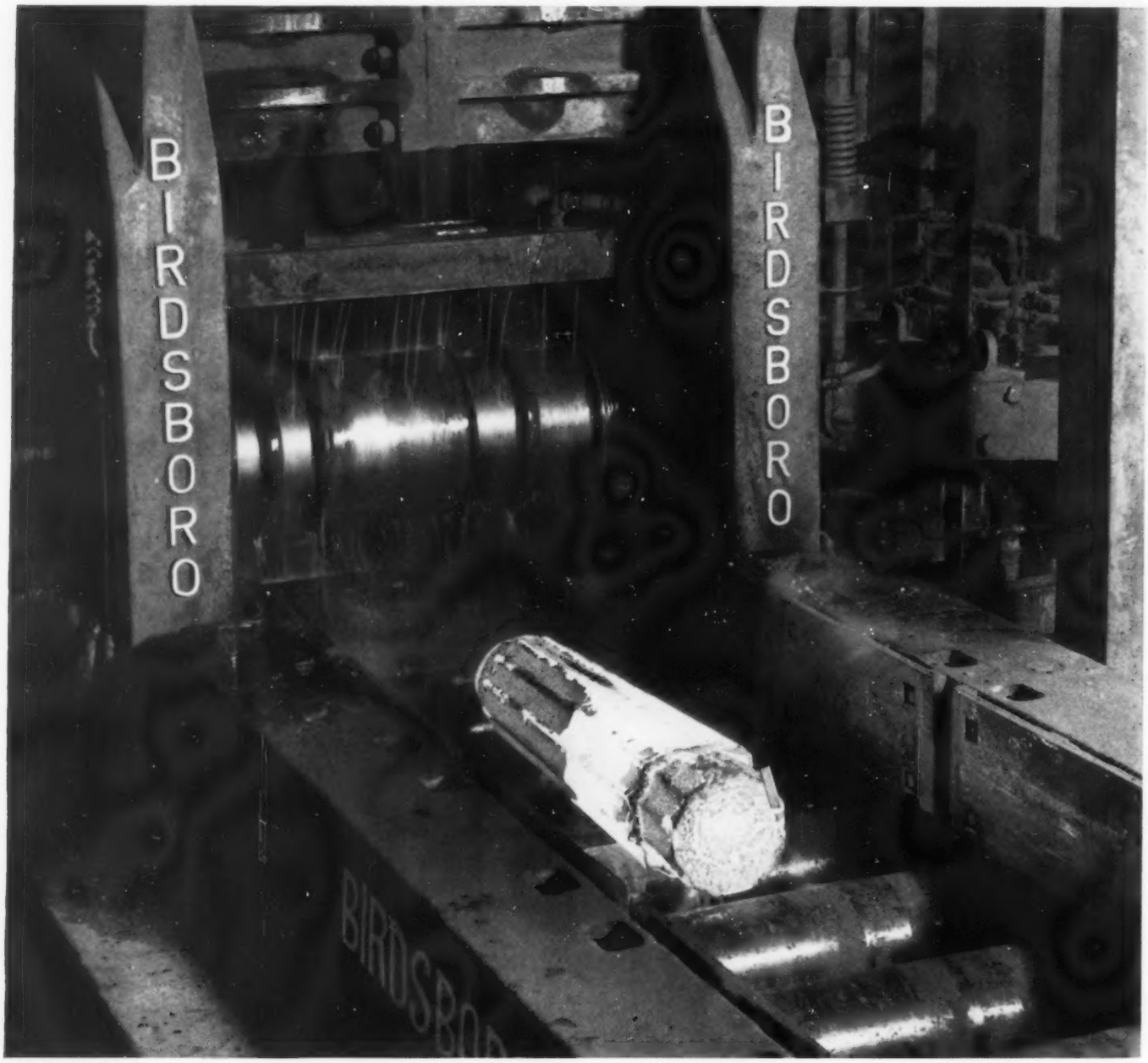

Photo Courtesy Atlas Steels Limited

MM-74-9

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STEEL FOUNDRY AND MACHINE CO.

STEEL MILL MACHINERY • HYDRAULIC PRESSES • CRUSHING MACHINERY • SPECIAL MACHINERY •
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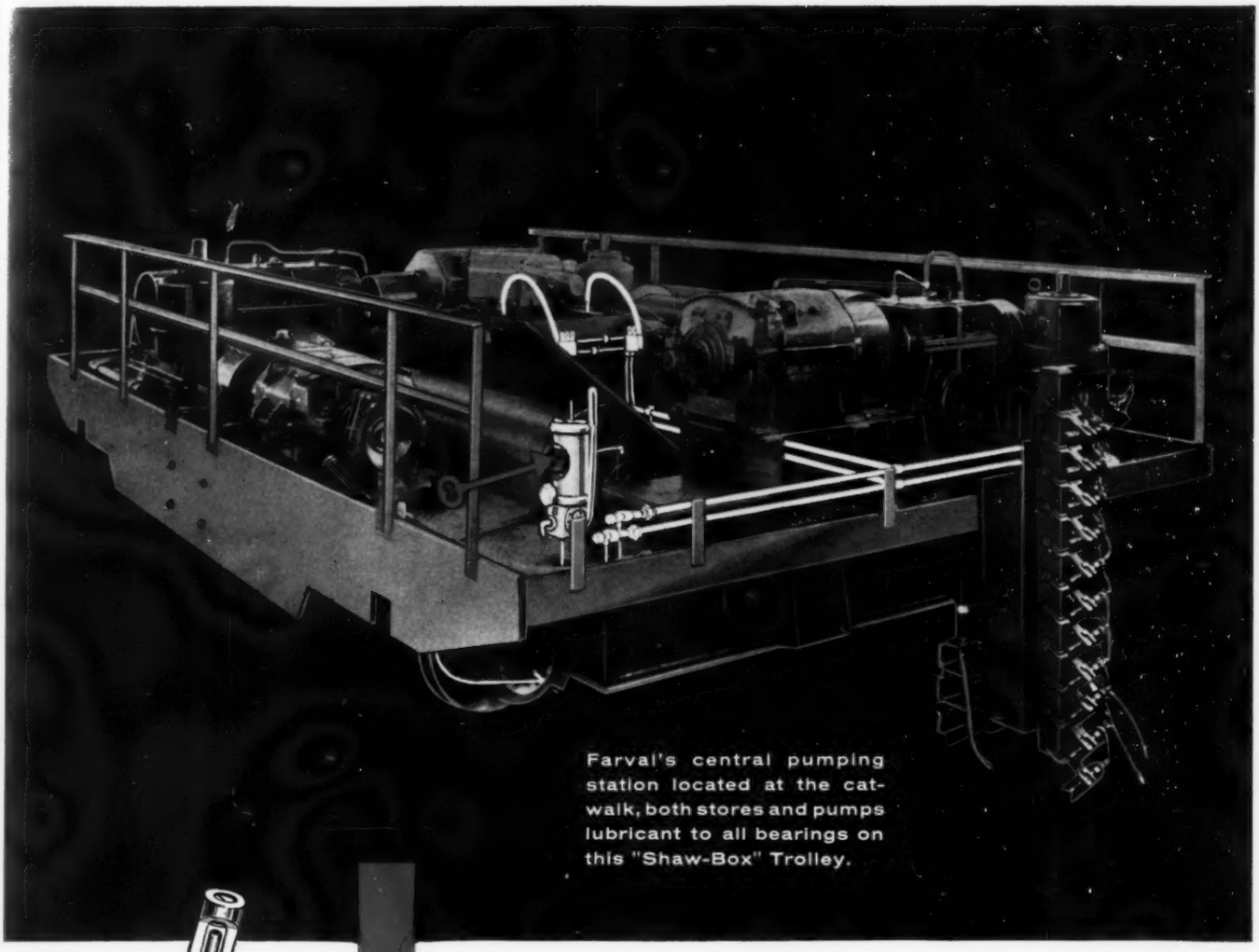
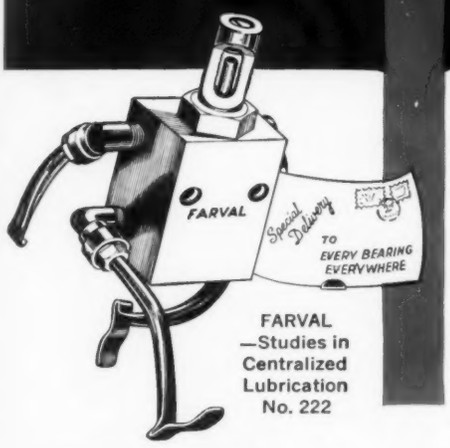


Farval's central pumping station located at the catwalk, both stores and pumps lubricant to all bearings on this "Shaw-Box" Trolley.



FARVAL
—Studies in Centralized Lubrication
No. 222

Farval helps 200-ton "Shaw-Box" Crane deliver dependable performance

RUGGED "Shaw-Box" cranes, built by Manning, Maxwell & Moore, Inc., moving plates, slabs or giant ladles in steel plants across the nation are noted for safe, dependable service under extreme operating conditions. One big reason for this performance is proper bearing lubrication . . . provided by Farval.

Farval's up-to-the-minute method sends measured amounts of lubricant to all crane bearings from a safe, centrally-located pumping station. Thus the need for men to crawl over the crane with hand grease guns is eliminated.

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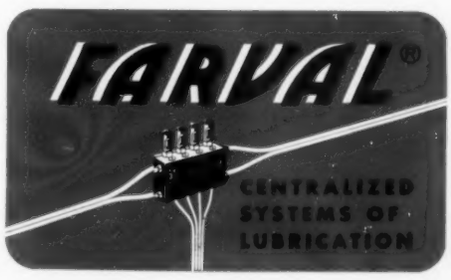

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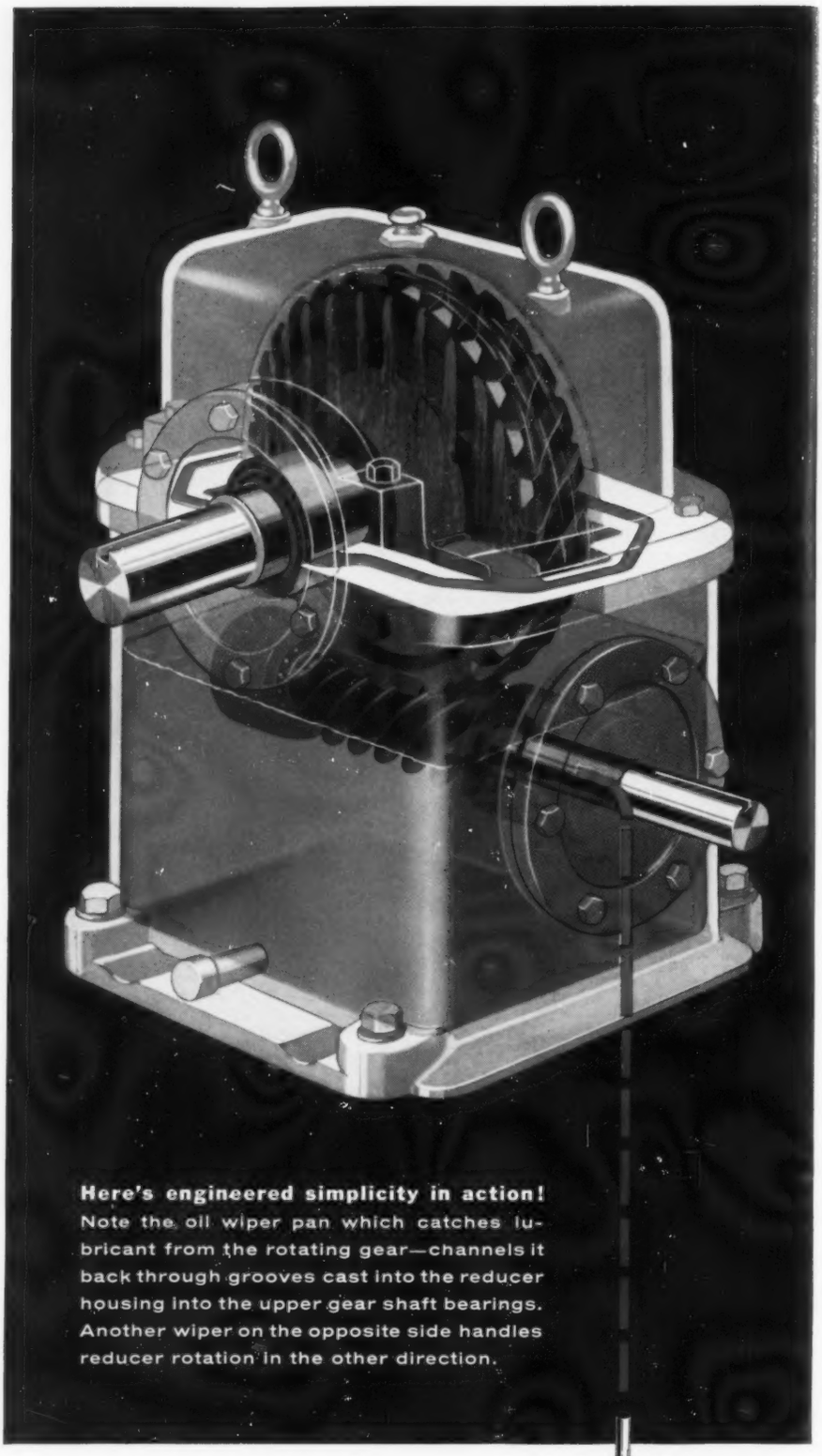

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Increased Costs of Production in Steel: the problem and possible solution

. . . . the combined effect of plant modernization and expansion by foreign steel producers and increased steelmaking costs in the U. S. has reduced U. S. exports and made foreign companies competitive in the world market . . . . the foreign challenge can be met only if the U. S. is able to keep future increases in labor costs in step with increases in man-hour production efficiency and if the U. S. replaces economically-obsolete equipment with modern facilities . . . .

by William T. Hogan, S. J.,
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SINCE the end of World War II the production costs of steelmaking have been on the increase. This is true despite the fact that three recessions have hit the economy of the country during the 13-year period in question.

Costs of production are difficult to measure with precise accuracy, yet there is no mistake about the upward trend, and it is possible to make some estimates of its magnitude. For example, the cost of purchased goods and services in the steel industry increased by 56 per cent between 1947 and June 1958. Straight-time regular wages have increased from an average of $1.23 per hr in 1946, to $2.83 per hr in 1958 while total labor costs, which include wages, overtime, vacation pay, pensions, insurance, social security and supplementary unemployment benefits, have risen from $1.40 to $3.58 an hr over the same 12-year span, an increase of 155 per cent. Interest charges on long term debt, an indication of the industry's expansion, have risen from $18,000,000 to $59,000,000 from 1946 to 1957. The cost of using capital, or depreciation charges, has risen from an annual charge of $169,000,000 in 1946 to $757,000,000 in 1957. This upward trend has been accentuated to some extent by rapid writeoffs of facilities on 5-year bases which were permitted by certificates of necessity. Finally, the cost of new plants and equipment has increased appreciably since the close of World War II. Thus every major item of expense has gone up markedly in the past 13 years.

As a consequence of the increase in costs there has been an increase in the price of steel during the same period. From 1946 to 1958 the composite price of a ton of steel advanced from $60 to $140 a ton. This increase has been reflected to some degree in the price of products made from steel although not to the extent as is commonly thought. For example, the average automobile requires approximately two tons of steel so that a $5.00-a-ton increase in steel prices would boost the cost of materials to the automobile manufacturer by $10 per car. A refrigerator requires 230 lb of steel, and thus the manufacturer must pay $0.56 more for the steel in each refrigerator.

The rise in the cost of producing steel and the increase in its price to the consumer has been considerable over the last 13 years; and what is more disconcerting, there is little prospect that this trend will be reversed. American manufacturers find such a situation particularly irksome because for generations by means of mass production and inventive genius they have been able to contain costs of production while maintaining a quality product. Thus, in spite of higher labor costs, they were able to outdistance foreign competition. This provided an ever higher standard of living for the American workman. Although the standard has improved since the end of World War II, much of the gain has been negated by inflated prices. It is of small comfort to have a wage double that of 1939 if prices have also doubled.

The increase in steel prices resulting from higher production costs has confronted the industry and the country with several serious problems. Four of these will be mentioned and discussed in some detail. They are:

1. The development of buyer resistance which is limited at present but which could well increase, to products made from steel.
2. Competition from other metals and materials.
3. Foreign competition in certain products and the threat of greater competition from abroad in the future.
4. The difficulties faced by the smaller steel companies, particularly those that are integrated, in making a profit when the industry's operating rate is low.

In regard to the question of buyer resistance due to

the higher price of products made from steel, the following observations must be made. The increase in the price of durable goods made from steel has occurred for the most part in a period of high prosperity when purchasing power was at an all-time high. Thus more cars and appliances have been sold during the past 10 years when these items were high priced than ever before. However, in 1958 the growth of the economy was stalled by a rather prolonged recession, and purchases of consumer durables declined sharply. This was particularly noticeable in the automobile industry. The questions arise, was it due in any way to the high price of steel in automobiles and, if so, to what extent?

There was too close a connection between the two; those who maintain that the cost of steel is at fault because steel is so fundamental to automobile production overstate the case. To begin with, steel represents a relatively small portion of the price paid for durable goods, such as automobiles, appliances and machinery. In the case of an automobile it represents about 10 per cent of the price paid for the car. Consequently, a decrease in steel price of 20 per cent would represent a decrease of only two per cent in the price of the automobile. The same is true for appliances. It is difficult, therefore, to believe that sales of consumer durable goods would improve if steel prices were cut as much as 10 or 15 per cent. Thus, while there is prosperity, high steel costs do not engender buyer resistance. However, this should by no means make the steel industry complacent, for buyer resistance will develop if personal income drops since the first item to feel it will be the consumer durables. This has happened during the past year. If steel costs and prices continue to rise without a corresponding increase in purchasing power, consumer durables will unquestionably continue to suffer. Thus the problem of buyer resistance really lies ahead of us.

COMPETITION FROM OTHER MATERIALS

The second problem concerns the question of substitute materials for steel. Here the popular impression, which is not supported by a study of the situation, would make things look worse than they really are. One hears the statement that aluminum and plastics are replacing steel in many uses and that this is only the beginning.

At present the only nonferrous metal that presents any competition to steel on a large tonnage basis is aluminum. Copper, titanium, zinc and lead offer no such threat. In the case of aluminum the problem can be narrowed down considerably since there are a number of uses in which aluminum and steel are not competitive, for example, foil, powder and certain types of castings. In other areas they are competitive, the most significant of these is construction. Here such applications as curtain walls, window frames, interior partitions and duct work for air conditioning find steel and aluminum in direct competition. The most spectacular of these applications is curtain wall construction or the exterior surfaces of large buildings. Here, however, aluminum has not taken a market which formerly was serviced by steel as both entered it about the same time.

Aluminum has bid for markets in two other areas formerly held almost exclusively by steel, transportation and containers. In transportation some inroads have been made in the automobile industry by aluminum parts for the engine as well as the body. One particular spot where aluminum has offered competition in recent years is the automobile bumper. In the container industry, however, the aluminum can is still a subsidized effort, and its success is very much in question.

The inroads of aluminum on steel are not due primarily to the increased cost of steelmaking but rather to the intrinsic nature of the material which gives it certain advantages in use. The cost structure of both industries is similar. They produce from extracted raw materials, require heavy capital investment, and have the same labor union contract. Thus heavy capital investment is needed in both industries, and labor costs increase at the same rate.

Between 1939 and 1946, due to the tremendous increase in aluminum capacity because of the war, the price of aluminum ingots fell 20 per cent. However, since then the price of aluminum products has gone steadily upward at about the same rate as steel. Table I gives a comparison of price indices for aluminum sheets and competing steel products and demonstrates the similarity of the price structure.

Thus it can be seen that aluminum and steel are competitive in several areas, but the contest will probably be fought out on a basis of quality and application rather than price, for aluminum is still about twice as expensive as steel.

Plastics have taken a small part of the steel market, but here again the problem is overstated. There are, as in the case of metals, many areas where plastics and steel are not competitive, yet there are others, such as reinforced plastic sheets used for walls and partitions, where there is competition with steel. Here the price is still in favor of steel by three to one. Plastics are also used in some automobile bodies, notably the high priced sports car; but this does not present a threat to the steel sheet in terms of general production in the automobile industry. Pipe is another area where plastics are used, but here again the competition is with copper and other items such as rubber hose.

Thus the threat from competing materials is not too great as yet. However, there is the possibility that a

TABLE I

Comparison of Price Indices for Steel and Aluminum Products Where Strong Competition for Markets Exists
BLS Wholesale Price Index
(1947–1949 = 100)

Year	Cold rolled sheets	Galvanized sheets	Electrotinplate	Aluminum sheets
1947	91.8	90.5	Not published	94.7
1948	100.7	102.5	in BLS until	99.4
1949	107.6	107.0	1954	105.9
1950	114.9	119.2		109.6
1951	120.4	132.0		118.1
1952	122.6	131.8		120.6
1953	130.8	128.7		130.0
1954	132.4	131.3	131.2	134.2
1955	137.9	138.8	136.4	142.2
1956	145.7	148.2	145.1	153.1
1957	158.2	152.5	151.9	162.0
1958	161.6	154.0	155.5	159.6

small share of the steel market may be wrested away in the next five to 10 years. The inherent properties of the competing materials rather than their prices will be the important factors.

FOREIGN COMPETITION

The third problem mentioned was foreign competition, both actual and potential. Much has been said of this in the past year because of the inroads that certain steel products have made during that time. This has been particularly true of barbed wire, concrete reinforcing bar, wire fence and nails. Yet, the total tonnage of imports in 1957 was not large. It amounted to 1,154,702 net tons as opposed to 5,176,289 net tons of exports. In the area of wire products, however, the impact of imports was severe; although there were only 63,775 net tons of barbed wire brought in, this amounted to 52½ per cent of the total market in the country. Imported nails were 23.3 per cent of our entire market, woven wire fence was 13.1 per cent, and reinforcing bars were 6.8 per cent. In the aggregate, imports constituted 1.5 per cent of the total supply of steel in the United States in 1957 while exports of 5,100,000 tons made up 6.5 per cent of the industry's shipments. The balance was favorable yet small consolation to the wire producers whose costs of production were far in excess of the foreign competition which was able to sell its barbed wire at $35 to $40 a ton less than the domestic product even after the payment of freight and duty.

Overall foreign competition in 1957 was not severe in terms of the entire steel industry, but the first six months of 1958 indicate a changing picture. Imports during this time were 724,090 net tons, which would mean an annual rate of almost 1,500,000 net tons. Exports for the first six months were 1,922,970 tons, an annual rate of less than 4,000,000 net tons. Thus it can be seen that the ratio of exports to imports would be lower than three to one, which is much less favorable than it was in 1957.

It can be said safely that actual foreign competition, with the exception of wire products, is not at present a serious problem for the American steelmakers even with present high cost and prices. However, when the future, or the potential, competition that foreign steel may offer is considered, particularly if costs and prices continue to rise; a different situation exists. It is quite conceivable that not only will foreign steel penetrate the American market to a greater extent, but also the industry faces continued losses in its export market. This loss of export market appears to be inevitable when the growing capacities of the European and Japanese steel industries are considered. Table II compares the output of foreign steel producers in 1948 and 1957.

In addition to the increased tonnage it must be recognized that both Europe and Japan have installed a number of modern mills for much of their older and, in many cases, obsolete equipment some of which was destroyed by bombing during the war. Since 1947 the steel industry outside the United States and Russia has installed over 75 new large mills and facilities of all types including primary mills, hot and cold strip mills, rod mills, plate mills, structural mills and electrolytic tinning lines. As a result many of these countries have a higher proportion of new equipment in relation to their total steel industry than the United States. Consequently this country can no longer count on overwhelming superiority of machinery to keep costs in line with the rest of the world. The foreign competitor now has as good a mill as we have. Further, their wage rates are from ¼ to ⅓ of ours. Therefore their total costs are lower, and they can compete actively with our steel. This competition is in the world market and will continue to be there much more so than in the American market.

TABLE II

	1948	1957
Canada	3,158,828	5,005,840
United Kingdom	16,661,792	24,304,000
Western Germany	6,129,890	27,081,306
Japan	1,891,547	13,807,410
Belgium	4,312,198	6,997,400
Luxemburg	2,698,430	3,850,334
France	7,976,243	15,427,791
The Saar	1,353,292	3,822,776
Italy	2,341,285	7,473,594
Netherlands	367,727	1,310,745
Austria	714,290	2,758,506
Russia	20,800,000	56,217,300

Because of the foregoing factors it seems that the United States will lose a greater and greater share of the export market in the years ahead. This is inevitable when we consider that the total production of steel in the United States is a much smaller share of the world production than it was 10 years ago. In 1948 the United States had 51 per cent of the world production; in 1957 it had dropped to 35 per cent, and projected capacities for the steel industries of the world indicate that by 1962 the United States will do well to hold its own at 35 per cent.

One area in which the U. S. is losing the export market is tinplate. This is due to its high costs and increased foreign competition. In 1957 the U. S. exported 752,597 net tons of tinplate, a decline from the all time high of 853,839 net tons shipped in 1955. In the current year exports for the first six months have been in the neighborhood of 196,000 net tons and will probably not exceed 400,000 net tons for the entire year. How much of this can be attributed to price and how much can be attributed to the installation during the last ten years of 23 electrolytic tinning lines is hard to ascertain. Undoubtedly, some combination of both factors would be the answer. It should be further noted that several more electrolytic tinning lines are under construction and consideration. The estimated electrolytic tinplate capacity of the steel industry outside the United States is in the neighborhood of 2,100,000 net tons while hot dipped tinplate capacity is 1,700,000 net tons.

In regard to other products, the competition for world markets is keen, and steel plates afford an interesting example. Japan has installed three modern plate mills since 1952 yet has shipped very few plates to the United States. However, Japan is exporting a great deal of plate tonnage to the United States in the form of finished products, the most notable of which is ships. In August, 1958, the Bulletin of the American Bureau of Shipping lists 55 ships destined for American owners and operators under contract or construction

in the Japanese yards. Many of these are large ships. Thus the Japanese steel industry competes indirectly with the American industry by shipping finished products to the United States.

In the matter of foreign steel operations and competition, there are several factors in our favor. First, productivity in the steel industry in Europe and Japan is low. Steel plants in both these areas employ more people per ton of production than corresponding plants in the United States—in some cases up to 30 per cent more. Consequently, many more man-hours are employed in the production of a ton of steel—this helps to reduce the wage advantage. Further, in the long run the standards of living will increase in areas outside the United States bringing higher wages and again reducing the gap. Nevertheless, the problem of foreign competition for markets outside the United States is real at the present time and will become more severe in the future. This may well take the form of competition for finished products made from steel rather than steel itself because densely populated areas are more interested in exporting finished products as it enables them to export labor value as well as materials.

To summarize the question of foreign competition, it can be said that the U. S. is in danger of gradually pricing itself out of world markets; this situation is serious.

THE PLIGHT OF THE SMALL COMPANY

The fourth problem that arises as a result of ever increasing costs in the steel industry is a very serious one for some small steel companies, particularly those that are integrated. The basic difficulty rises from the fact that these companies are faced with the same or greater costs as the larger producers yet lack many of the advantages of the larger companies.

First, a number of small companies do not have sufficient raw materials of their own so that they are forced to purchase them in the open market with a consequent increase in cost of $4 to $5 a ton.

Second, a number of small companies are operating a considerable amount of high-cost obsolete equipment, which again adds to the cost of production. This should be replaced, but the price of new mills is high so modernization must be carried out at a slow pace and in some instances has been postponed indefinitely.

Third, the small company usually has one principal mill which must operate regardless of the demand for steel. Thus it does not have the advantages of the large multi-plant company which in a period of reduced operations can operate its low-cost facilities full time and gradually reduce or shut down activity on its high-cost facilities. Further, the small company very often does not generate enough of its own scrap so that it must go to the scrap market where premiums are charged for scrap. Coupled with these disadvantages, the small company must sign the same labor contract as its larger competitor who often operates more efficient equipment. In addition, with few exceptions, their plants are located in the same geographic areas as the larger competition so they have no freight advantage.

When all these factors are put together, it is little wonder that a number of small integrated companies lost money during the first six months of 1958. This was not universally true since some were able to come up with a profit. However, the difficulty, a result of increased costs, remains; and should the industry operate at less than 75 per cent capacity for any length of time during the next ten years, the problem will be accentuated. Increased costs on all fronts have put the small, integrated producer in an unfavorable position; some solution to his problem must be found.

SOLUTIONS

The above four problems, the result of increased costs, are serious in the aggregate. Further, they show every tendency to become more so in the next few years if adequate measures are not taken to solve them. It is recognized that the solutions do not rest entirely with the steel industry since much of the difficulty is a result of general inflation in the economy. This was proved when the steel industry tried to stem the tide of inflation in 1948 by reducing prices and withholding a wage increase from its employees. The attempt was a failure as other elements in the economy completely negated the effort. However, the industry can and must strive diligently toward the solution of its problems. In so doing it can work to provide:

1. Some means to keep the increase in labor costs within the range of increased productivity or efficiency.
2. The replacement of economically-obsolete equipment with modern facilities.
3. More effective corporate organization and operation.

Labor costs—As previously stated labor costs have been increasing since the close of World War II and have been in excess of productivity increases. This trend is in part responsible for higher prices; and if it continues, there is little hope that the price of steel can be kept stable. Thus every consideration must be given to finding means for reversing it. The specific problem is how to keep labor costs within the range of increasing productivity. Clearly the co-operation of labor is necessary for both labor and management must come to the realization that recurring increases in the price of steel cannot be tolerated. Such continued increases will accentuate the problems previously discussed and work to the detriment of all. Further, the time is not far off when increased labor and other costs will no longer be easily passed on to the consumer. We have already reached such a stage in some steel products, such as wire, where prices were not advanced this year despite wage increases.

How then can the wage cost be kept down? One suggestion is that any further increases in wages come, as far as possible, in the form of incentive pay. In this way all wage increases would depend on either greater or more efficient production making it unnecessary to pass them on in the form of higher prices.

Admittedly, this is easier said than done, but there are incentives in operation in many segments of the steel industry today; some companies have installed them for their entire management and salaried personnel and with highly satisfactory results. Incentives

could be worked out on the basis of production quotas or meeting cost standards so that even in a period of less than capacity operations it would be possible for the workmen to make incentive pay through efficient operations. This plan, which would require acceptance by the union, is not a piecework plan, nor would it reduce the men's pay. There remains the base rate of pay to which the incentive would be added, and the base rate ranges from $1.96 an hr in job classes 1 and 2 to $3.97 an hour in job class 32. Most of the man-hours worked, however, fall in job classes 8 and 9 where the average base pay is about $2.40 per hr.

The employees of the steel industry could increase their take home pay under such an incentive system, and such a system would keep the rising cost of labor within the bounds of increased productivity. It may not be easy to work out a satisfactory plan, but the problem of increasing labor costs is serious, and serious problems can very rarely be solved easily. Any effort expended in the direction of a solution will be worthwhile.

Modernization of obsolete equipment—Throughout the steel industry in this country exist a large number of mills and other facilities which are economically obsolete. This is true in spite of the billions of dollars that have been spent to modernize and expand since the start of World War II. Fortunately, much of the sheet, strip and tinplate equipment is modern, but there are blast furnaces, open hearth shops, primary mills, rod mills, bar mills, structural mills and some plate and tube mills with old, high cost equipment. Several dollars per ton are added to the cost of steel by the operation of these facilities; this has been a factor in the high price of steel.

It is management's responsibility to replace high cost facilities with modern efficient equipment. The problem here is the lack of adequate funds to do the job. It has been estimated that the complete modernization of the steel industry would cost between $3,500,000,000 and $4,500,000,000, a high figure indeed; but complete modernization is an ideal. If 75 to 85 per cent of this goal could be achieved it would be a tremendous help. The significant question is where to get the money for the new equipment, which has become more costly in the last 15 years? The price of a blast furnace installed in 1946, for example, was about $10,000,000; the same installation today would cost in the neighborhood of $25,000,000.

The money can come from four sources: depreciation accruals, reinvested profits, borrowed funds and new capital from the sale of stock. Strictly speaking, enough money to replace obsolete equipment, at least in kind, should come from depreciation accruals. However, the tax policy on this matter is unrealistic in that it does not allow for the declining value of the dollar due to inflation. Steps have been taken to bring this to the attention of Congress, and it is hoped that some provisions will be made to enable businessmen to reclaim the purchasing power of their original investment. This effort to get tax relief on depreciation should have the enthusiastic support of all those engaged in business where long lived capital equipment is used. If the change goes through, much of the problem concerning where the money can be found to modernize industry will be solved.

Management can also reduce the cost of modernizing equipment by the installation of multi-purpose mills, e.g., combination rod and bar mills. In some instances the addition of cooling beds to a rod mill have enabled the operators to run reinforcing bars as well as rods on the same mill. Further, the installation of sintering plants has greatly increased the output of blast furnaces. For example, a blast furnace with a 28-ft hearth in 1949 and 1950 produced about 1400 tons a day; with sintered ore today, the same size furnace produces 2500 tons. Thus for the cost of a sintering plant the company, in effect, almost added another blast furnace.

A continual process of modernization will give us the equipment to help hold down costs of production. This is not only desirable but necessary if the industry is to serve the economy well in the next decade.

Corporate organization—The problems of small companies, as mentioned above, require special attention for the companies are small only in relation to the larger producers in the steel industry. Many of them employ over 10,000 men and have capital stock in excess of $50,000,000 and sales which have been in the area of $200,000,000 in some postwar years. They are a necessary part of the economy of this country which needed every pound of their steel output during all but a few of the last 18 years. Yet, in spite of this their size, raw material supply and, in some instances, their relatively high cost and obsolete equipment have placed them in an unfavorable position. In addition, product mix has been a problem of the small company without a rounded line of products when there was a decline in the market for its principal output. Further, it is more difficult for a smaller company with a smaller capital structure to borrow the amount of money required today to modernize and balance its facilities. Another difficulty facing this type of company is the fact that it usually has but a single plant so that increasing freight rates tend to restrict its market.

Should the industry operate at 85 to 90 per cent of capacity during the next few years, it is possible that the small company will be able to finance a modernization program; but it must be kept in mind that there are now (1958) 141,000,000 tons of ingot capacity in the country. By next year the figure will be 147,600,000 tons; 90 per cent of this is 133,000,000 tons while 85 per cent is 125,000,000 tons. Thus an 85 per cent rate of operations would require a production of 8,000,000 ingot-tons in excess of the record year 1955, a figure that is not impossible to attain but which few are willing to forecast for any year in the next five.

What then are some possible solutions to the problems of the small integrated company? First, tightening cost standards, installing management incentives to assure the attainment of these standards, and diversifying the output of a mill wherever possible are steps that can be taken. Second, the small companies might well bargain separately with the union for their labor contracts. This is done technically today, but in the last analysis they sign the same basic contract that the rest of the industry accepts. Third, by presenting well worked out plans for modernization, particularly those that will return a profit, it should be easier to obtain adequate financing for them. Finally, if these fail, and it is not possible for the small

company to modernize and cut the cost to stay competitive, then a possible alternative would be the merger of two or more such companies whose facilities and locations complement each other. Such a merger would have the effect of reducing overhead costs by providing a multiple-plant location in which its more efficient facilities could be used during recessions. In general, the company would have a broader base for its activity with respect to operations and markets. It could also very well help to solve raw material problems for the small company and, with a broader base possibly help generate enough capital to finance improvements. This is in no way a novel suggestion, but it could be the solution to serious problems facing a segment of the steel industry today.

SUMMARY

It probably will make little difference if these problems are not solved this year or even next year. However, if they are disregarded, they will become more serious in the next five years and could result in acute economic trouble.

Discussion

PRESENTED BY

W. L. LONGNECKER, Manager of Operations, American Steel & Wire Div., United States Steel Corp., Cleveland, Ohio

WILLIAM T. HOGAN, S. J., Professor of Economics and Director, Economic Program, Fordham University, New York, N. Y.

RONALD C. WINDAHL, Market Analyst, Republic Steel Corp., Cleveland, Ohio

W. L. Longnecker: I would like an elaboration on the area of foreign competition with the effect of the favorable factors referred to.

William T. Hogan, S. J.: In spite of the fact that the hourly wage rate in the steel industry in the United States is about three times as high as the foreign rate, there are some factors that tend to compensate for this differential.

First, we have higher productivity in our operations since it takes 1.6 man-days to produce an ingot ton in the United States compared with 4 man-days in Europe. There is a distinct advantage here, yet it is not as great a one as we enjoyed in 1949 when the ratio was 1.8 to 6.3 man-days per ingot ton. It should also be pointed out that the reduction in the differential has wiped out the advantage we held in labor cost per ingot ton, and in effect has placed us at a disadvantage. In 1949 our labor cost per ingot ton was estimated at $2.00 less than the European figure, but by 1957 it was $7.00 higher than the European cost.

Thus our greater productivity is quite beneficial; otherwise the labor cost differential per ton of steel between Europe and the United States would be much greater than it is now. By way of explanation, it should be noted that the lower productivity in Europe and Japan stems from the fact that they employ many more people than we do in a steel plant of comparable size and output. As long as this practice persists, their productivity will remain lower than ours.

A second favorable factor in this matter of foreign competition is the general rate of wage increase in Europe compared to the United States. Europe's wages are still much lower than ours but are increasing at a more rapid rate. For example, between 1950 and 1957 wages in England were up 61 per cent and those of the European community 72 per cent while the increase in the United States during the same period was 42 per cent. These are percentages, and as such can be deceiving for it should be held in mind that Europe and England started from a much lower base. However, they can be comforting since to some extent the more rapid increase abroad will narrow the gap in costs of production between American and foreign steel.

The third factor is the concerted drive on the part of Europe's and Japan's labor for a higher standard of living, expressed in a desire to have more of the material good of life. It can be exemplified by the advance from the bicycle to the motorcycle stage in Europe. This will intensify the pressure for wage increases. Another element to be considered in this respect is the change in strategy in the European labor unions who have switched from the general over-all political approach to a more pointed economic drive for increased wages.

Ronald C. Windahl: I wonder if you would care to comment further on buyer resistance.

William T. Hogan, S. J.: There have been many increases in the price of items made from steel in the past 12 years. These include all of the so-called consumer durable goods such as automobiles, refrigerators, etc. Yet, I would like to stress the fact that the increases were by no means due only to the rise in the price of steel for the cost of steel in these articles is not as great a portion of the total as many people think. Although consumer durables have gone up in price, sales of these products have been at record levels almost every year since World War II. Only in the last year or two has buyer resistance appeared bringing a sharp decline in sales of some durable goods, notably automobiles. In seeking the explanation for this buyer resistance, a combination of three factors must be considered, namely, the increase in price; the recent decline in purchasing power; and the possible degree of market saturation.

I think it was a combination of the three elements rather than the increase in price alone. In the first place, prices of durable goods have not increased very much in the past year, and in previous years high prices did not deter the spending of a public equipped with purchasing power. Further, the element of market saturation must be taken into account. We have over 55,000,000 passenger cars for a population of approximately 170,000,000 people, which means that there is one car for every three persons. Thus the degree of saturation is fairly high. It would seem that at present the automobile market will be confined to a replacement and second car market, and it is precisely in the second car market that price can make a difference. This would also apply to a second unit in other fields, such as household appliances, television sets, etc. Therefore, I think it can be said that, in the purchase of the first car or other durable goods, the increase in price has had little or no affect as long as there was sufficient purchasing power; but price is important when purchasing a second unit. ▲

Recent Developments in Design and Control of Hot Strip Mills

by R. W. Barnitz, Chief Electrical Engineer
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. . . . automatic programming control provides single-stand reversing roughers with sufficient capacities to keep steel in the hot strip finishing stands at all times at J & L's Aliquippa and Cleveland works . . . .

OVER the years, especially in the basic industries, greater productivity at lower unit costs has been obtained by resorting to larger machinery and/or higher production speeds. This has meant higher investment costs; and as the practical limits on size and speeds were reached economically, the law of diminishing returns has meant smaller returns per unit of investment. Some segments of the steel industry are experiencing this.

The original hot mills were the reversing type with its larger labor force and low production rate. As knowledge increased in the art of rolling steel and higher production was required from these mills, the continuous hot strip mill came into being in the middle thirties. This mill consisted of a number of roughing stands, usually four, a delay table and four to six finishing stands plus the usual scalebreakers, side guides, shears, loopers, etc. The strip on leaving the last finishing stand continued down a runout table and was coiled in the downcoilers. The roughing stands were generally driven by wound-rotor motors with a flywheel on the shaft and were spaced so that the slab was never in adjacent stands simultaneously. The finishing stands were driven by d-c motors on a common bus, variable voltage system. Since these were adjustable speed drives, the strip could be in all stands at the same time.

The size slabs and tonnage involved, although large at that time, were relatively small compared with those today. The spacing between roughing stands as well as permissible drafts determined the maximum slab size.

ALIQUIPPA WORKS

In recent years with the costs of new equipment and installation going ever higher, a maximum effort was made in the design of the Aliquippa hot strip mill to keep these costs to a minimum. Because the mill was to be installed between existing facilities, another item of major importance was the lack of room in the area proposed for the mill. Also, the mill had to produce at a rate equal or better than existing mills, and the coils produced had to be larger than those produced on most existing mill installations.

Using the above criteria as a basis, a reversing roughing mill was suggested in place of multiple roughing stands as on a standard continuous mill. This reduced costs by having one stand do the work of several; the layout gave enough space on the tables for the desired coil size; and the modern electrical controls permitted a design that keeps the finishing train full of steel at a considerable savings in cost.

Since this mill was to replace the operation of four roughing stands, it was obvious this mill had to be installed to include the following:

1. Fast and accurate screw settings since adjustments must be made on each pass compared to adjustments on each schedule as on continuous roughing mills.
2. Fast table and mill reversal so that no time is lost in getting the steel back into the mill for the next pass.
3. Automatic edger speed and table speed compensation since these speeds must be synchronized with mill speed and adjusted for mill draft.

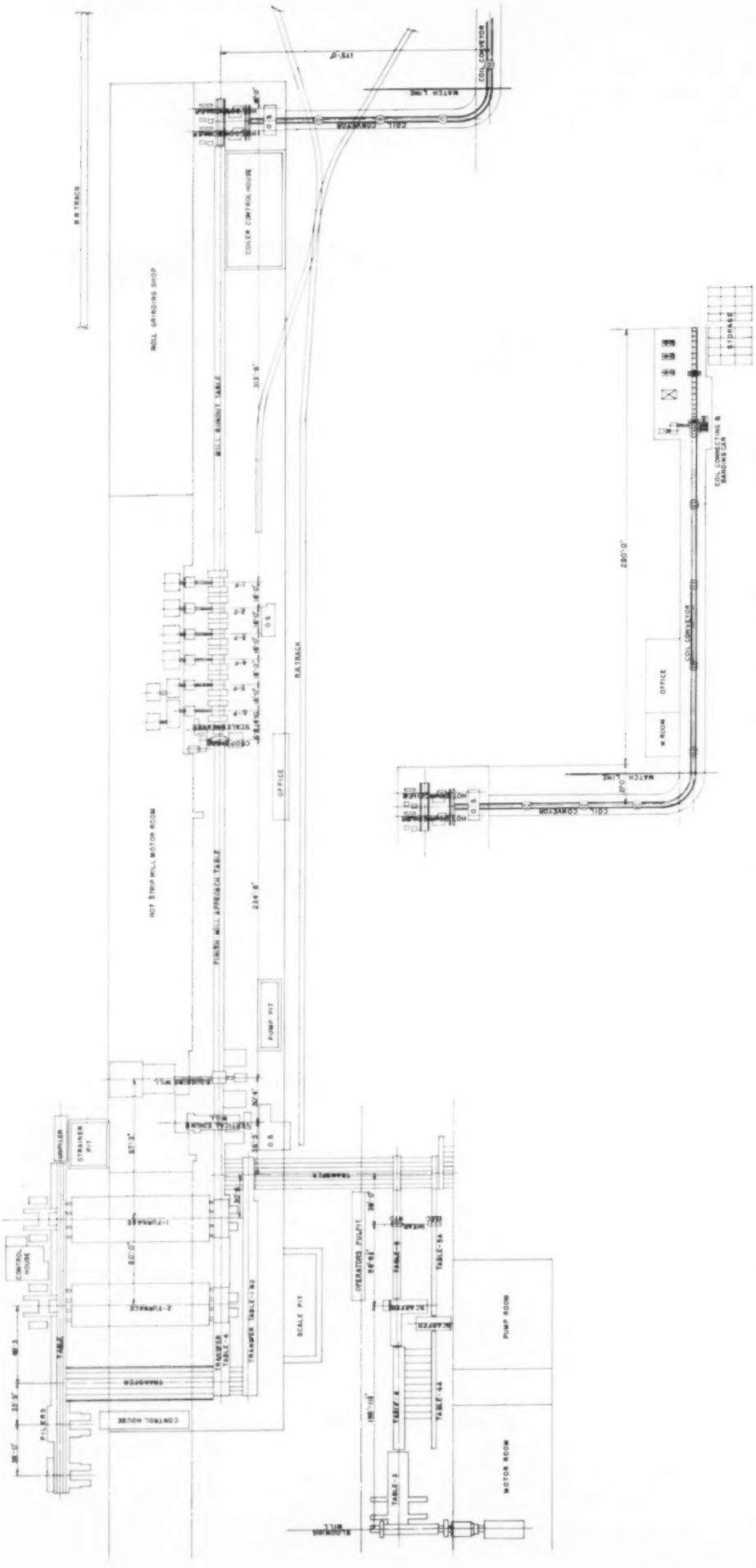

Figure 1 — The new 44-in. hot strip mill at J&L's Aliquippa Works was made semi-continuous, because of space limitations. However, automatic control of the rougher gives it a rolling capacity large enough to keep steel in the finishing stands at all times.

4. Automatic controls so that operator fatigue is reduced to a minimum.

The above reasons made it imperative that attention be paid to all details of the equipment and its controls. In addition, it was necessary to completely program the operating functions. This analysis, although referring to the new mill at Aliquippa, is equally applicable to the existing Cleveland mill. That installation had a light roughing train which rolled far too small a coil size.

Figure 1 is a block layout of the 44-in. hot strip mill at the Aliquippa Works. The product required of this mill together with the space limitations at this plant were the governing factors in the over-all layout. The mill was designed to produce gages from 0.048 to 0.375 in. in a width range from 11 in. min to 41½ in. max. The narrower widths were bevelled-edge skelp. Since it was desired to direct roll from the blooming mill as well as slabs weighing 600 lb per in. of width, it became apparent at a very early date that a continuous mill due to its length was not advisable at the Aliquippa site. As can be seen in Figure 1, it was necessary to install additional runback tables and transfers to attain the above features even when the shorter semi-continuous mill was designed.

Two continuous type 86 ft long, 26 ft wide, coke oven gas or natural gas fired furnaces, rated at 150 tons per hr each, heat the slabs for rolling. The mills consists of:

1. 42-in. diam vertical scalebreaker.
2. 26-in. diam attached edging mill.
3. 44-in. 2-high reversing rougher.
4. Flying crop shear.
5. 16-in. diam scale breaking pinch roll.
6. Six 4-high finishing stands with:
   a. Backup rolls—46 in. diam x 42 in. long.
   b. Work rolls—22.5 in. diam x 45 in. long.

The finishing train is also equipped with three sets of vertical rolls for rolling bevelled-edge product. No. 1 edger located ahead of No. 1 finisher is 26 in. in diam, No. 2 and 3 are located at the delivery sides of No. 3 and 5 finishers respectively and are 16 in. in diam.

A 305-ft long runout table carries the strip from the finishing stands to two driven mandrel type downcoilers. These units handle strip from 11 in. wide to 41½ in. and from 0.048 to 0.375 in. in thickness. It was necessary to install power-driven rotary side guides ahead of the coilers to prevent edge damage, especially when rolling bevelled-edge skelp. Forming an 11-in. wide x 60-in. outside diameter coil in a downcoiler without damage to the product, extracting and individually banding it, and nest banding them in units of three coils (for stability on edge) required considerable planning. Figure 2 shows schematically how this was accomplished. A full ring type extractor head pushes the coil from the coiler mandrel to a matching mandrel on the coil transfer car and places it against the vertical arm supporting the stub mandrel. The transfer car moves to the centerline of the discharge conveyor and upends the coil to the twin chains. The stub mandrel then lowers it between the chains, and the conveyor moves the coil ahead. After clearing the upender arm the stub mandrel returns to its original position ready for the next cycle. The coil is carried in this position, i.e. (eye vertical) to the end of the conveyor where just preceding the upender a circumferential band is applied manually to prevent the end from unwinding. From here the coil passes to the downender, which employs a retaining arm when handling narrow coils, where it is down-ended. While still being retained it is rolled sidewise to a coil banding car equipped with spinner rolls and side guards. The guides and car are movable so that two or three coils can be placed edge-to-edge and then by means of the spinner rolls turned to apply two, three or four nesting bands. This being finished, the nested unit is returned to the conveyor and proceeds to the unloading point where it is handled by either mobile carrier units or overhead cranes. Coils that are wide enough to be stable (20 in. or over) are handled directly from the downender to the saddle type discharge conveyor.

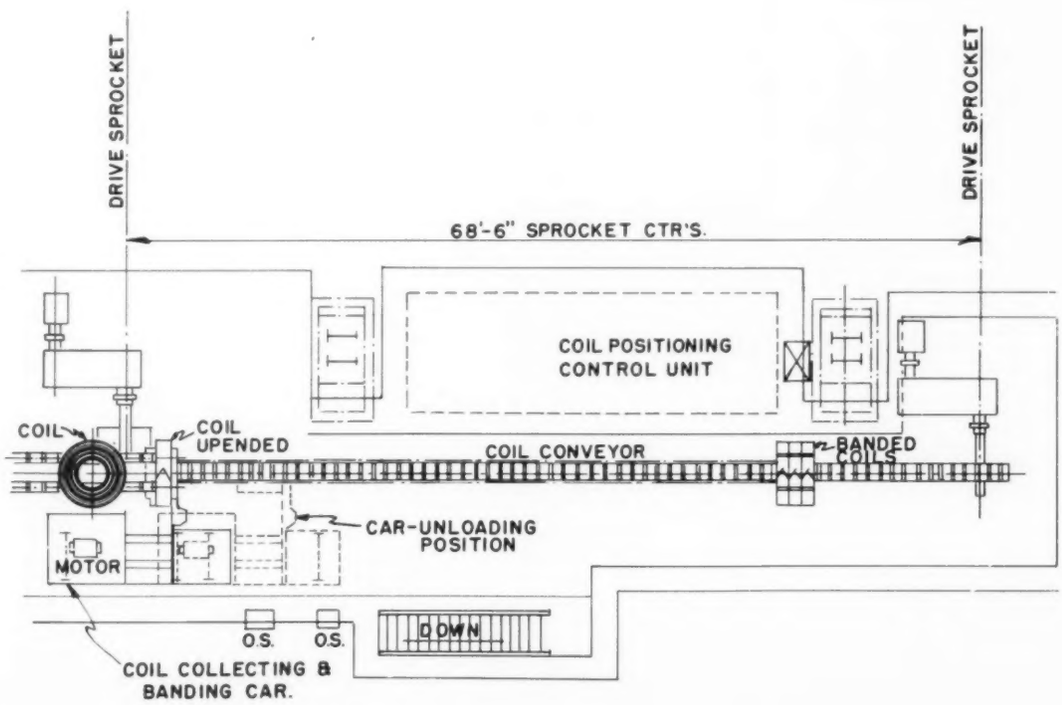

Figure 2 — This coil connecting and banding station ties coils together to give minimum combined widths of at least 20 in. for coil stacking stability.

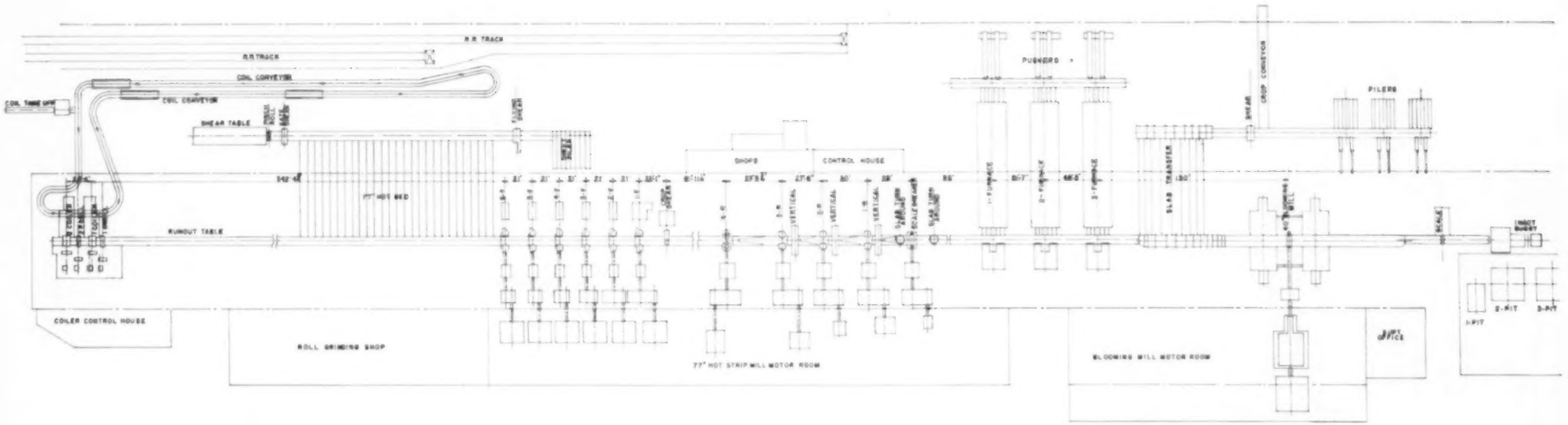

Figure 3 — Layout of the hot strip and blooming mills at J&L's Cleveland works before the expansion program of 1955.

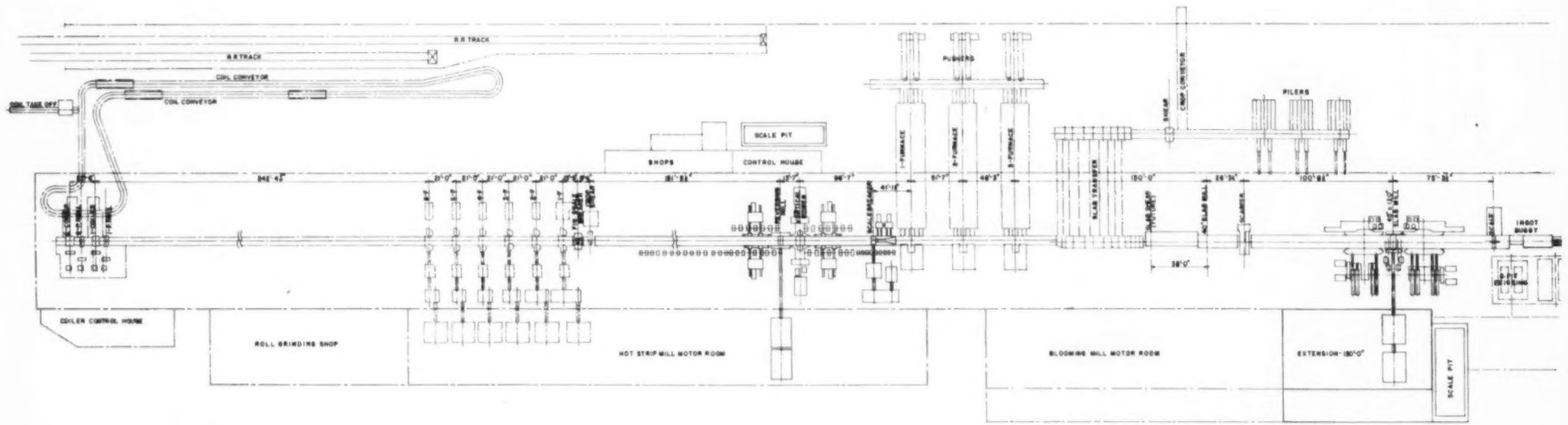

Figure 4 — In the new layout of the Cleveland works the old blooming mill and the complete roughing train of the hot strip mill were replaced by a new 46-in. high-lift blooming mill and a 80-in. 4-high reversing rougher.

The Aliquippa mill is driven by a 6000-hp twin drive motor having a speed of 40 to 100 rpm that provides a top mill speed of 1150 fpm. Each of the 3000-hp motors are connected to a 2500-kw, 700-volt generator. These generators are duplicates of other units at our Cleveland and Pittsburgh works. The attached edger drives are two 375-hp 230-volt motors connected in parallel on a 1250-kw, 460-volt generator. The mill table motors are mill type frame 608, and the screwdown drives are mill type 612. Both are on variable voltage generators. Two pilot generators are driven by the main motors for speed matching the edger and table drives with the main mill. These generators have special excitation systems to compensate for mill draft.

The finishing stands are driven by 3000-hp, 750-volt motors, each connected to its individual 2500-kw generator, which are also duplicates of generators in other plants. The main motor fields are provided with motor field current regulators to give more accurate control of motor field current. This will provide more stable field control and will eliminate motor speed change due to changes in field temperature and will also provide more rapid speed change by field control.

The individual generators for each stand motor will provide greater flexibility for speed control, allow a wider speed cone, and limit the short circuit direct current available. Voltage regulators on each generator with IR drop compensation are provided in order to hold more accurate motor terminal voltage and stand speed regardless of load. The screwdown drives are 75-hp mill type motors with the No. 2 and 3 stands on variable voltage. The runout table motors are 3 hp d-c drives.

CLEVELAND WORKS

Figure 3 shows the original layout at Cleveland Works before the 1955 expansion program was started.

The blooming mill unit consisted of a 40-in. blooming mill with a slab transfer to the shears, tables and pilers in an adjacent building. The slab size available from this blooming mill was limited to a 49-in. width. Three slab furnaces, 80 ft long and 18 ft wall-to-wall, heated the slabs for the 77-in. hot strip mill shown in the same figure.

The roughing train consisted of:

1. Slab turn-around No. 1.
2. Scalebreaker 38 x 77-in. 2-high.
3. Slab turn-around No. 2.
4. No. 1 rougher 38 x 77-in. 2-high with verticals.
5. No. 2 rougher 38 x 77-in. 2-high with verticals.
6. No. 3 rougher 38 x 77-in. 2-high with verticals.
7. No. 4 rougher 49 & 27 x 77-in. 4-high.

It will be noted that all stand spacings are very close and that the holding table is only 81 ft 11 in. long. These limitations coupled with the fact that a 49-in. wide slab was the maximum available, made it necessary to spread or cross grain for wider widths, and resulted in slab weights as low as 57 lb per in. of width.

To correct this condition, better the quality picture, and at the same time increase over-all production without too great an expenditure a modernization program was initiated.

Figure 4 shows the new high-lift 46-in. blooming mill and 80-in. 4-high reversing rougher which have replaced the old blooming mill and the complete hot strip mill continuous roughing train respectively. To make room for the installation of an in-line continuous hot scarfer and for future installation of a shear to permit direct rolling, the new blooming mill was moved 127 ft further away from the hot strip furnaces. This also permitted installation and complete testing of the new blooming mill without dismantling the older installation. The mill at present produces slabs up to 68½-in. wide but has the capacity for 75-in. widths. It is limited only by the amount the existing shears and tables could be spread. All new tables and mills were designed to handle 72-in. finished product which is the capacity of the finishing equipment at Cleveland Works. The three heating furnaces were widened from 216 to 233 in. wall-to-wall by refractory changes within the existing casings, and the forced draft fans were changed from 60,000 to 75,000 cfm. Calculations indicate these changes will result in a capacity of 120 tons per hr per furnace compared to the original 100 tons per hr.

From the end of the furnace delivery tables to the flying crop shear the entire roughing train and tables were removed and replaced by a modern 80-in. 4-high reversing mill preceded by a 77-in. 2-high horizontal scalebreaker and a 45-in. diam vertical edging mill. In addition, a new scalebreaking pinch roll was installed between the flying crop shear and the No. 1 finishing mill. The horizontal scalebreaker has rolls 33½ x 77 in., the vertical edging mill 45 in. diam, the reverser 54 x 80 in. backup and 38 x 81 in. work rolls, and the No. 2 scalebreaker 26 x 77-in. long.

The only changes made beyond this point were modernization of the finishing mill controls and strengthening of the coil handling system. The latter was done to permit processing coils up to 25,000 to 28,000 lb maximum.

After studying numerous methods of increasing slab size (with the finishing train fixed as well as the hot strip furnaces), the reversing mill described was selected. As seen in Figure 4, the holding table length increased from 80 ft 11 in. to 154 ft 5 in. with a resulting increase in lb per in. of width. Since this mill has been in operation only a short time and since slab weights must be kept within the capacity of the original finishing train, it is hard to predict just what we will achieve in coil weights. Results so far have been very encouraging on trial runs of heavier slabs as is shown in Table I.

The new reversing mill is powered by an 8000-hp twin drive motor having a speed of 40/100 rpm. The edger is driven by two 750-hp 90/225 rpm 700-volt motors. The motor-generator set has four 2500-kw generators, duplicates of units in other plants. These are normally connected with three units in parallel to supply the two rougher motors and the other to feed the edgers. The switching is arranged so that the mill can be operated

TABLE I
Comparison of Handling Capacities of New and Original Hot Strip Mills at J & L's Cleveland Works
Trial Rolling of Heavier Slab Weights

	Original mill	New mill
Slab weight, lb.	4085	20,000
Gage, in.	0.090	0.090
Width, in.	66	66
Lb per in. width	66	303

with any one generator out of service with the remaining three split so that one is on the edger bus and the remaining two on the rougher bus. The mill table motors are mill type 610, and all screw adjustment drives are mill type 614, both on variable voltage systems.

CARD PROGRAMMING

As previously stated, in order to get the most out of the mill it was necessary to completely program the operating functions. The information for rolling up to nine passes is punched into a card giving the scalebreaker, mill and edger openings. Mill and table directions and speeds are programmed as well as draft compensation which coordinates the edger and entry table speeds for the draft on the mill. In addition, some sprays are programmed by the card, and other sprays as well as side guards are a secondary function of the control. On automatic operation, the operator needs to do only two things, press the "schedule advance" and the "pass advance" pushbuttons. The first reads the information from the punched card, and the second starts the operation of the mill. Subsequent passes are made automatically, the mill stops, and its screws return to the initial settings on the last pass. Three other modes of operation are provided: semi-automatic in which the operator must push the button to initiate the next pass, a second semi-automatic in which only the screw openings are programmed, and complete manual operations.

Figure 5 is an artist's sketch of the reversing mill. The operator selects the proper card for the steel to be rolled, inserts it in the card reader, and presses the schedule advance pushbutton. The reader transfers the data from the card to the programming equipment. The operator then presses the pass advance pushbutton which sets the mill for first-pass operation. The scalebreaker, screws, edger, and main mill screws are set to the proper opening. The mill speed and rear tables are run in the forward direction at the programmed speed. The scalebreaker, edger and front tables are run in the forward direction at a speed compensated for mill draft. In order to be synchronized with the slab, these must run at a slower speed. The side guides which have previously been set to the proper width by hand, go to the "in" position on the front side of the mill and the "out" position on the rear side. As the slab goes through the scalebreaker, a hot metal detector turns on the scalebreaker descaling sprays. This is a secondary function of the programming and is interlocked so that it only operates on the first pass. As the slab proceeds through the edger and the mill and the tail end approaches, a second hot metal detector slows the equipment to a predetermined speed of about 250 fpm. This is necessary in order to assure constant runout from the mill during deceleration and reversal. As the steel clears the mill, a third detector signals the equipment; and the programming sets up the operation for the second pass. Mill screws are reset. Scalebreaker and edger screws are opened as the scalebreaker is used only on the first pass and the edger is used only on odd passes. Mill, edger and tables are reversed with the rear tables programmed at a compensated speed. The rear guides are set to the "in" position, the front guides are set to the "out" position, and the delivery descaling sprays are turned on. The bar reverses on the tables and the same slowdown and reversal of equipment is made as on the initial pass with the bar runout adjusted to clear the edger rolls. Subsequent passes follow the same procedure until the final pass when all screws and guides return to their initial positions. In resetting or adjusting to a larger opening the screws are adjusted to overshoot so that they are always coming down or into position. This offsets the effects of any ex-

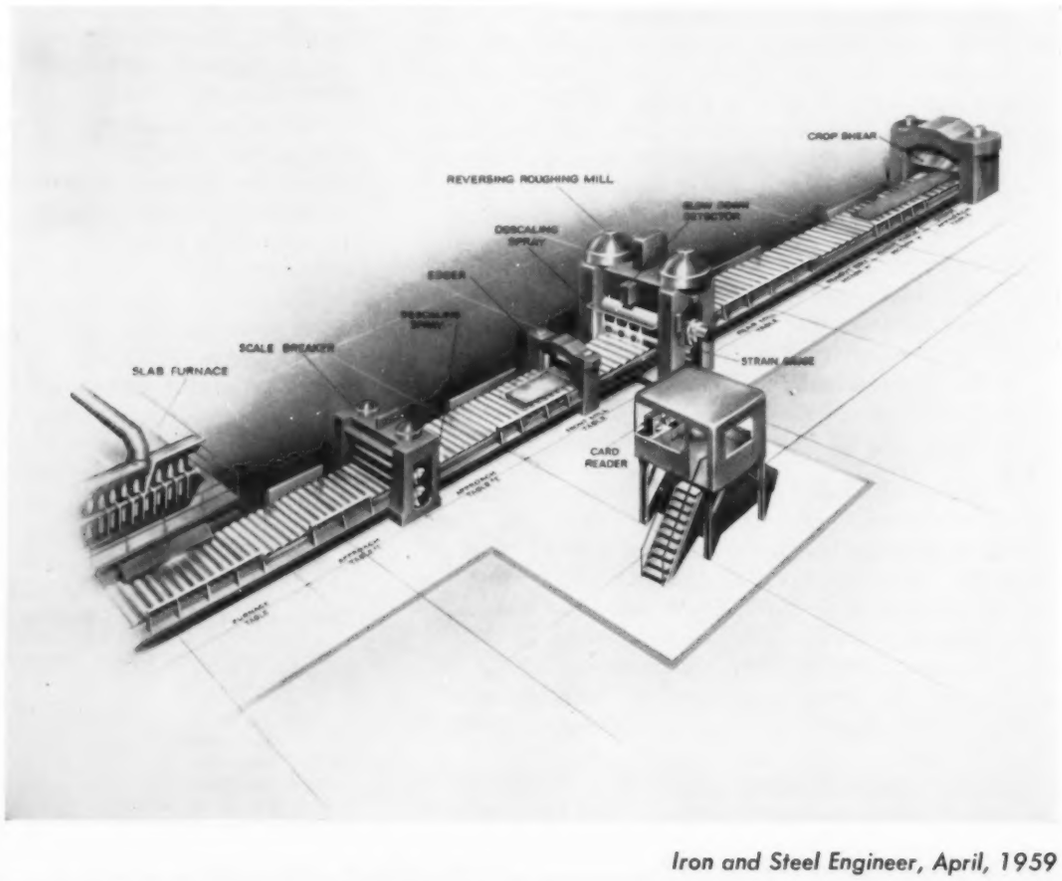

Figure 5 — Artist's sketch of the reversing mill.

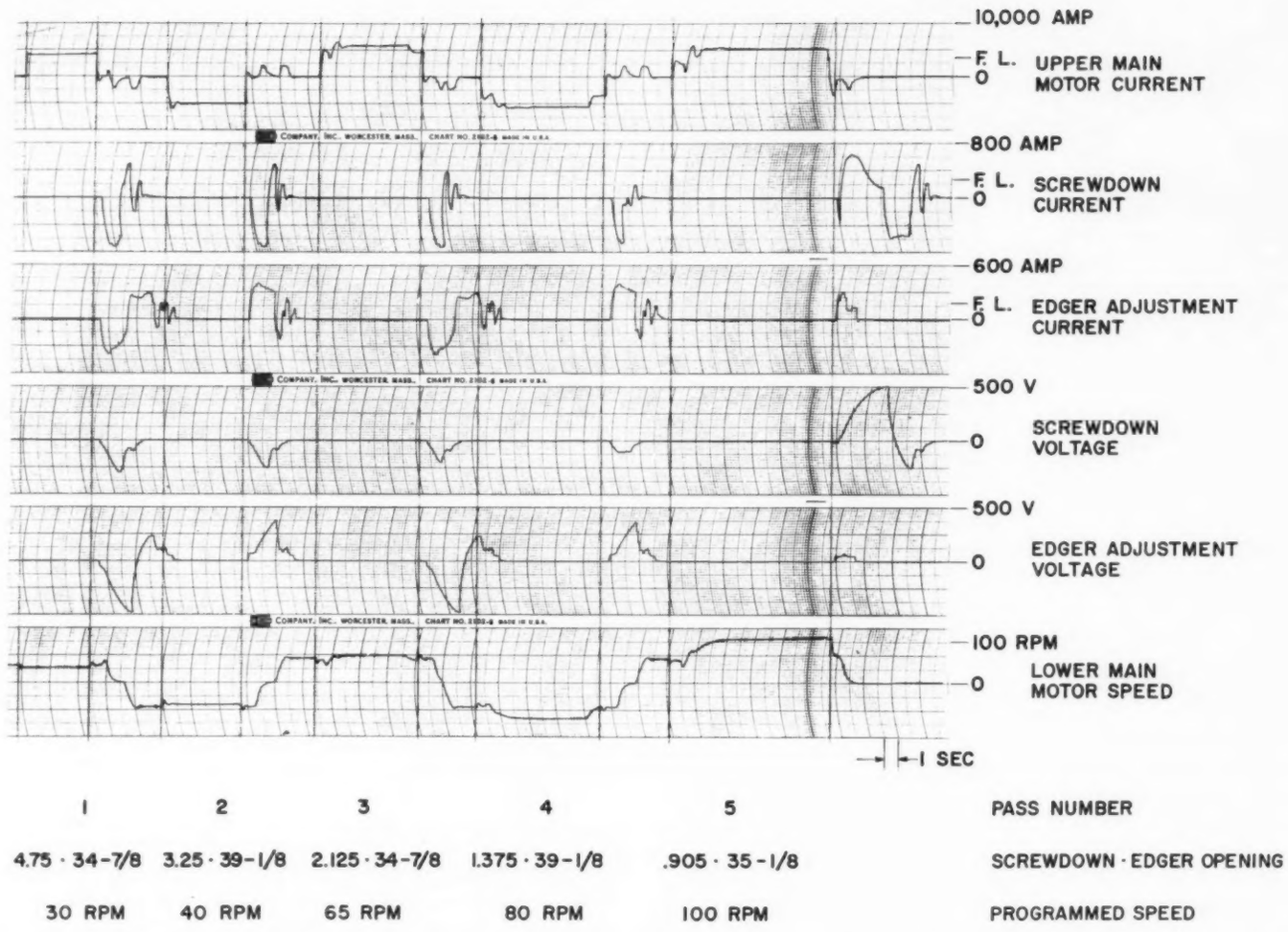

Figure 6 — Oscillograph record of the upper main motor current, screwdown current, edger adjustment current, screwdown voltage, edger adjustment voltage and lower main motor speed for a completely automatic, five-pass rolling of a 6-in. slab to 0.905 in.

cessive clearance since the adjustment is always made in the down direction and keeps the error in setting to a minimum.

The oscillographic record shown in Figure 6 shows the coordination between the main drive equipment, the screwdowns, and the edger adjustment when operating under completely automatic control. These records were made while using card No. 808 to roll a 6-in. slab down to 0.905 in. in five passes. The screwdown and edger roll openings along with the programmed speed for each of the five passes are shown at the bottom of the illustration. Reading from top to bottom, the oscillogram shows the upper main motor current, the screwdown current, the edger adjustment current, the screwdown voltage, the edger adjustment voltage, and the lower main motor speed. Guide lines have been drawn to show the periods in which steel is in the mill. When the steel leaves the bite of the rolls as seen by the hot metal detector, the screwdown and edger adjustments are made; and the mill is decelerated to a stop. As the screwdown adjustment is about to be completed, the mill and tables are accelerated for the next pass. This sequence is so timed that the mill does not stay at standstill for any appreciable time but decelerates and accelerates with very little delay. Since passes 1 and 2 were programmed at less-than-base speed and base speed, the steel entered the mill and was rolled at programmed speed. On passes 3, 4, and 5 the steel entered the mill at approximately 40 rpm and accelerated under current limit control while rolling. The speed to which the mill accelerated during rolling was limited by the programmed speed on the card. As the tail end of the slab approached the mill as seen by the slowdown hot metal detector on the entry side of the mill, the mill was automatically decelerated for passes 3, 4, and 5 since the mill was operating at speeds higher than base speed of 40 rpm.

Note that the repositioning of the screwdown between the passes is accomplished in from two to three sec depending on the magnitude of the change in screwdown setting and is done in the closing direction without overshoot. After the last pass, when the rolls are being opened in preparation for the next slab, the control equipment is designed to intentionally overshoot in repositioning so that the final screwdown setting is made in the closing direction in order to take up any backlash in the gearing. Since the edgers are only used on the odd-numbered passes, the card is so punched to cause them to open up approximately four in. before each even pass in order to clear the slab. The opening of the edger is also done with an intentional overshoot in order to insure accuracy. This is not required on most settings of the edger in the opening direction since these are usually

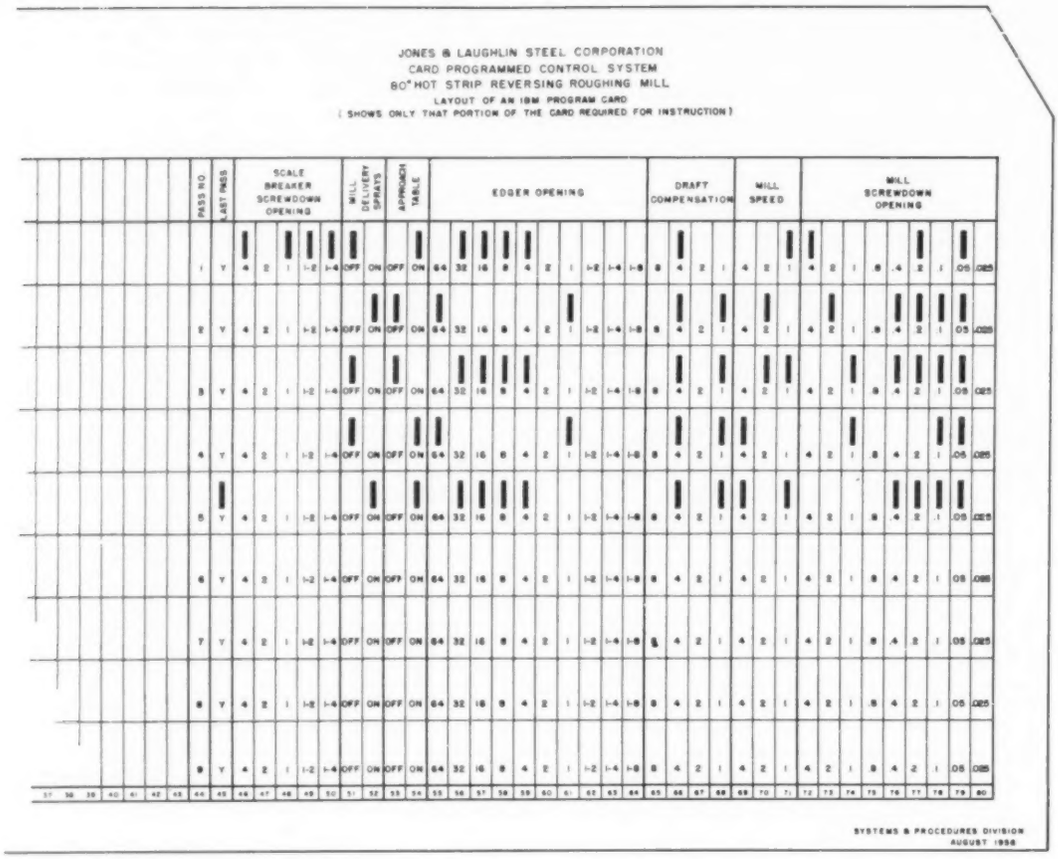

Figure 7 — This punched card contains all the information required for automatically rolling up to a nine-pass schedule.

used to move the edger out of the way in order to allow the slab to pass between them without any width reduction, but the intentional overshoot has been included in order to insure accuracy when repositioning the rolls from one schedule to another. For instance, if a 30-in. wide slab were rolled for a given schedule, and the next schedule would call for a 40-in. edger roll setting; this positioning would have to include an overshoot in order to insure an accurate setting. Note that the intentional overshooting of the edger before the even passes does not delay the operation of the mill since the edger is well away from the steel when the pass is started even though it has not reached its final position.

The programming equipment consists of a card reader, control equipment and the signal device indicating the position of the slab to be controlled. The Aliquippa mill uses a standard IBM card reader with the necessary wiring revisions and is the type that reads the complete card and stores the information in the memory circuits. It uses the standard card which is punched on a standard card punch and uses a binary numbering system as shown in Figure 7.

On the card pass one of the mill screwdown openings is set at 4.25 in. which is the sum of 4 plus 0.2 plus 0.05. This system uses considerably less space on the card for the same information than that required by the decimal system.

The indicating device on the screws are selsyn transmitters, and the control equipment, which is located in the motor room, houses the receivers, converters, amplifiers and switching. The equipment is designed for up to nine-pass operation.

In order to illustrate the signal process operations incorporated in the card control, Figure 8 shows a block diagram of the controls for the horizontal roll screwdown on the Aliquippa mill. In this system the information applying to screwdown is transferred from punched card into storage by the card reader. An analog signal representing actual roll separation is transmitted from the mill to an analog-to-digital converter for conversion into digital form. When the operator presses the "pass advance" pushbutton to initiate rolling operations, digital reference information for the desired roll separation is extracted from storage and supplied to the digital difference detector. At the same time, the signal corresponding to actual roll separation is also passed to the digital difference detector. Here a subtraction operation yields a resultant signal representing the difference between the actual and desired roll separation. This signal is then processed by the digital-to-analog converter to yield an analog signal for input to a magnetic amplifier. When the output of this magnetic amplifier is supplied to a rotating amplifier, an adjustable voltage drive adjusts the screws until roll separation is equal to that specified by the punched card. Operations of other units are similar to the one described.

The programming control on the Cleveland mill has the same functional operation. A block diagram is shown in Figure 9. The cards are similar, but the card reader reads out only one pass at a time so that no storage element is required. This digital information is fed through the code converter and selsyn simulating transformer into the comparator where the programmed setting is subtracted from the roll separation signal, the resultant of which is amplified and used to reset the screws to the programmed setting.

In the initial stages of design, the initiating signals of the programming functions were given the greatest consideration as it was considered that this tie-in between operating components would be most critical. Of the

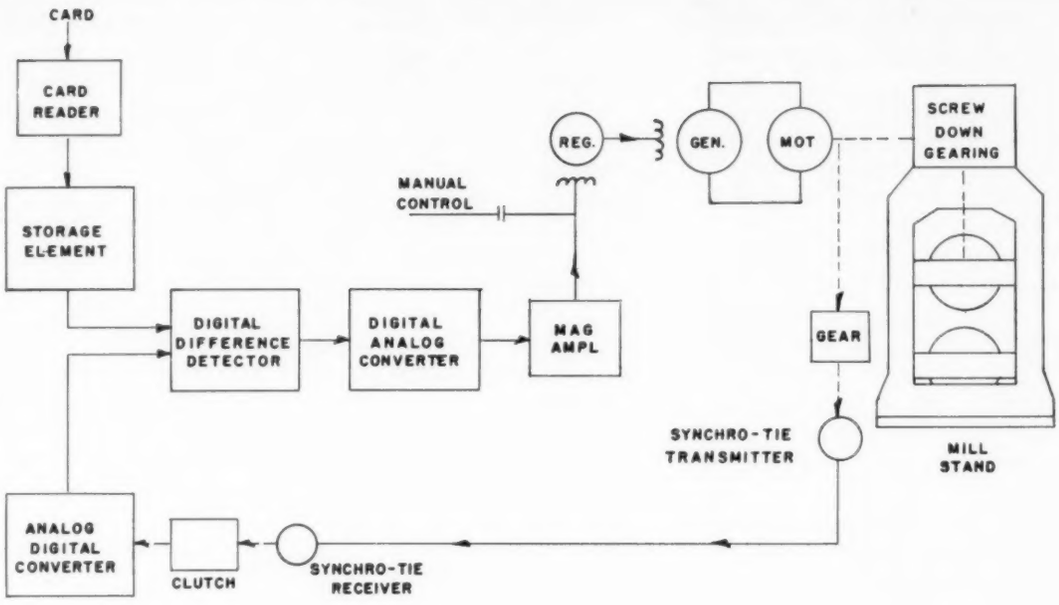

Figure 8 — Card programmed, automatic horizontal roll screwdown control for the hot strip mill rougher at the J&L's Aliquippa works. A storage element retains the screwdown readings for the entire schedule thus the card is read but once.

signals, the one indicating that steel was out of the mill posed the greatest problem; it was finally decided to put a strain gage on the post of one housing. This gage, although it produced an adequate signal, did give occasional erroneous operations while steel was still in the mill. This was caused by slippage of the rolls due primarily to scale of the slab, and the signal pickup was changed to a strip radiation detector focused on the steel at the bite of the rolls. This has proved satisfactory and except for occasional cleaning of scale and dirt deposits has given a minimum of maintenance and operating problems.

At the time of initial operation, since the Aliquippa mill was new and the operating crew had to be trained from scratch; it was somewhat of a problem to get the programming into operation. The operating department was interested in getting the roughing operators familiar with manual controls and preferred them to run the mill this way. At the outset we ran under fully automatic conditions about an hour a day. At that time the final adjustments had to be made, and the operators preferred to use the manual controls. However, when the controls were finally adjusted and as mill production increased and the operators gained confidence in the equipment, they preferred to use it constantly as they have been doing since.

The problems encountered in starting up a new mill are many, electrical, mechanical and operating. Besides the normal adjustments to be made on the electrical equipment in the current limit, load balance, speed match circuits, etc., and the adjustments in the mechanical equipment including the lubrication and piping problems, the operators had to predetermine the various rolling schedules. The schedules were setup for five-pass operation on $5\frac{1}{2}$ to $6\frac{1}{2}$-in. slabs and seven-pass operation on larger slabs. On some schedules reduction on the third pass was high whereas the first two passes were low so that some cards were repunched and schedules rearranged for optimum operation. On one type of steel the schedule was changed to seven passes for all slabs. In order to give the operator some control over and above the card and still roll completely automatically, a speed limiting selector switch was installed in the pulpit. This was in addition to the vernier adjustments on his desk. The control has since been changed so that the steel enters the mill at base speed and is accelerated under current limit up to the programmed speed. Should the pass require an abnormal amount of power because of cold steel or for some other reason, this control automatically limits top speed at a point within the capabilities of the drive.

In starting these two strip mills, no more than the

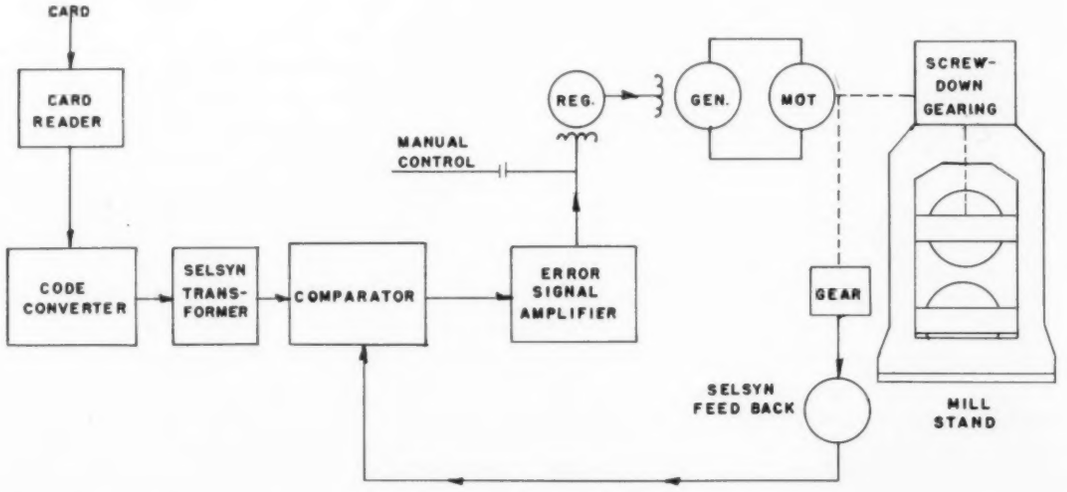

Figure 9 — Card programmed, automatic horizontal roll screwdown control for the hot strip mill rougher at the J&L's Cleveland works. A storage element is not required because the card is read for each pass.

usual amount of trouble and delays have been experienced. However, any delay reducing tonnage is always bothersome.

The original location of the hot metal detectors was changed several times before arriving at the present positions. Air was added in order to keep the scale buildup off the lens. A better signal pickup device is desirable because of the costs of operating this unit.

Short-stroke control of side guards and verticals, accomplished by slip clutches, brakes and limit switches, has caused considerable delay. At present experimenting is being done with a different control employing a differential gear in an attempt to obtain more accurate settings. At points where possible, use of electric-driven screw adjustment for positioning is being supplemented by air or hydraulic power for short-stroking against positive stops.

Of interest especially to maintenance men is reversing and blooming mill spindle lubrication. The change to driving the newer mills with individual motors eliminated the mill pinions so that the spindle shock and end thrust that was once taken by the pinion stand is now transmitted directly to the motors. To protect against this hazard, an automatic lubricator was designed and installed on the blooming mill and 80-in. reversing mill spindles at the Cleveland Works. To date they have proved very successful, and plans are to extend its use to the Pittsburgh and Aliquippa Works.

Both mills are at present somewhat in their infancy and will undoubtedly encounter conditions that will require some change in their original design.

Discussion

PRESENTED BY

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A. S. Urano: As we advance more and more into the age of automation, the automatic operation of steel mill processes demands increased attention in the following two areas:

1. Complete co-ordination and co-operation between equipment builders and steel customer.
2. Increased component and system reliability.

In the complex automatic programming of a reversing hot mill, where accurate controlled positioning and split-second timing are required for maximum continuous production, it is imperative that the steel customer detail the true operating requirements to the best of his ability. In turn the electrical and mechanical manufacturers must co-ordinate their equipment to best meet these operating requirements. In addition, suitable flexibility must be built into the equipment to make minor field adjustments as actual running conditions dictate. For example, when operating a reversing roughing mill in fully automatic, it was found that the sequential initiation of screwdown movement to set the screws for the next pass, then the stopping of the mill, and the reversing and acceleration of the mill and tables in the opposite direction were too slow. The time to roll a slab was long, and cooling of the slab resulted. It was necessary, after observing operation of the mill to initiate operations so that the slab was just about to enter the mill as the screws reached their preset position for the next pass.

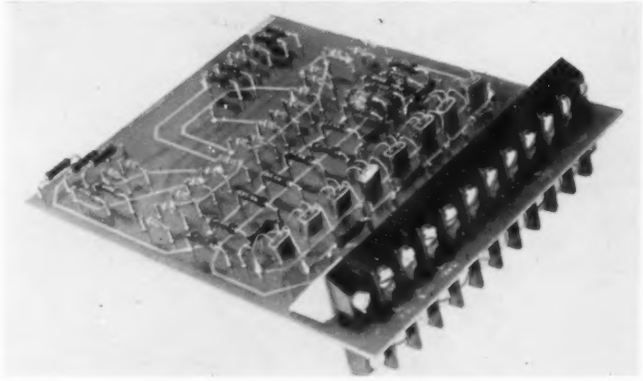
Another important point of co-ordination is the determination of the screwdown mechanical and electrical system for the programming control. It is no longer sufficient to pick a large enough motor drive, a gear ratio to transmit high speed and suitable torque to the screws, and a standard adjustable voltage electric drive system. In order to provide optimum speed and positioning of screws to match the steel customers rolling requirements, mechanical and electrical factors such as screw friction, minimum increment of screw change, repetitive accuracy of stopping, screw backlash, optimum gear ratio with matching drive torque and positioning control, and other factors must be analyzed as a whole system before selections of electrical and mechanical equipments are made.

As steel mills become more fully automated, another major problem that the electrical manufacturers must cope with is one of component and system reliability. Under automatic programming operation, an increased number of electrical equipment components must operate every pass in proper sequence and timing. A failure in any component can cause considerable time delay.

To optimize the reliability of such control systems we have instituted the following program:

1. Utilization of static devices for repetitive operation.
2. Simplification of circuitry.
3. Sectionalization of functions into modular construction for ease in maintenance and replacement.
4. Built-in maintenance test and fault indication.
5. Customer personnel training program.

Figure 10 — This is a typical component board used on the reversing rougher. Its transistors, diodes, and resistors are connected by printed circuit.



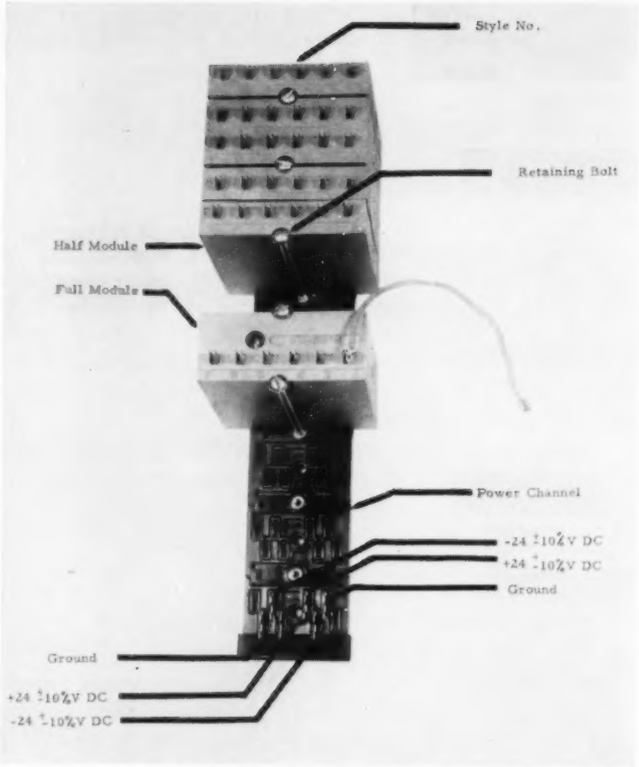


Figure 11 — Printed circuit component boards and fault finding devices aid maintenance of this controller used on the reversing mill at Aliquippa.

A prime example is a completely static photo-electric card reader and programming control panel with plug-in switching units to perform functions previously performed by stepping switches and relays.

Now that several hot mills are in operation with card programming control, it is important to evaluate this feature and to justify the automation of steel processes in the future. It is hoped that the steel industry can make this evaluation from the following standpoints:

1. Increased yield due to consistent, continuous operation and better dimensional uniformity.
2. Fewer maintenance and downtime problems.
3. Smoother scheduling of production.
4. More process and operational information for better, more simplified automatic controls.

John Greiner: The Aliquippa rougher started out at 5000 hp and finally ended up at 6000 hp. The oscillograph chart shows that when rolling 35-in. wide slabs, the thermal capacity and top speed ability of the 6000-hp motor are fully utilized. Also, it is apparent that the screwdown motors, when resetting from the last pass to the first pass, are momentarily operating at 500 volts. This full utilization of the equipment, plus the fact that the roughing mill keeps the finishing train filled, indicates that the equipment was carefully chosen.

Very little was mentioned about the vertical scalebreaker on this mill. Would the authors care to comment on the speed in feet per minute? It would be interesting to check the transit time of a new slab when traveling from the scalebreaker to the reversing mill against the screw resetting time. This interest is occasioned by the fact that roughing scalebreakers are notoriously slow.

Also, did you use one or two motors on this scalebreaker?

R. W. Barnitz: The vertical scalebreaker is driven by two 500-hp 360-rpm 60-cycle motors. They are not tied together mechanically but are driven through a telescopic rod and geared in at a speed of 223.5 fpm. The speed approximates the compensated entry speed of the mill and edger. Since the distance between the scalebreaker and attached edger is one foot greater than the maximum slab length, there is no time lost between these two units.

Figure 12. — This programmed digital automatic control provides a very recent 53-in. blooming mill with more functions than those in the reversing rougher design.

E. H. Browning: I would like to show briefly some of the evolutionary aspects of the card programmed control used with reversing rolling mills.

Figure 10 shows a component board used in the first programmed digital automatic control built. This controller was used on the reversing roughing mill described by the authors. Printed circuitry is utilized and the transistors, diodes and resistors are mounted as shown.

Figure 11 shows a view of the controller used on the reversing roughing mill at Aliquippa. Note the arrangement of the printed circuit component boards and the fault findings devices provided to aid in maintenance work.

Figure 12 shows a view of a more recent design of programmed digital automatic control. This unit is for use in programming the automatic operation of a 53-in. blooming mill. This controller provides the same functions as the one used with the mill described by the authors plus several other functions necessary for the full control of a blooming mill. The printed circuit board type modules were replaced in this design by encapsulated modules. Figure 13 shows one of these newer modules in which the transistors, diodes, resistors, etc., are contained within a solid resin compound and in which connections are made by plugging the unit into a connector channel and by slip-on connectors.

Referring again to Figure 12, note should be made of the memory storage element used. This is the magnetic core plane located in the lower left hand corner of the controller.

H. H. Angel: My comments are in the form of questions. The first covers training for maintenance. I understand J&L had some maintenance men taking a training course to learn about the functioning of this equipment and how to maintain it. One of the major problems confronting us today is how to train men to take care of the equipment properly. I would like to know how the maintenance training program is organized.

My second question is: How do you keep a record of various punched cards which the rolling mill operators must use? For example, you would probably require different punched cards for the rolling of the same size slab into the same size product if the widths would vary a great deal. According to the paper, the rolling covers a width of 11 to 41½ in. Possibly the authors have worked out schemes with the mill men to handle those cards in a very efficient way.

The next question covers the authors' comment that a better signal pickup device is necessary. Possibly he would like to comment further on this item.

My last question is in reference to the field regulation used for controlling the current in the motor fields of the finishing drives in order to keep the speed constant —starting out with cold fields and reaching normal temperature sometime later. I would like to know whether there is any provision in the tachometer generators to reduce the error in speed readings between starting cold and then running after the warmup period, assuming of course that they have shunt field windings.

R. W. Barnitz: Relative to maintenance on the programming equipment, this installation was entirely new, and actually very few people outside of the designers and the electrical equipment industry knew very much about it. The manufacturers put on a course which lasted three days. The first day was spent on the

Figure 13 — The transistors, diodes, resistors, etc., are contained within a solid resin compound; and mounting and wiring are accomplished by connecting the unit into a connector channel and by slipping on connectors.

general operating conditions and what we might expect to get out of the programming. At this session we had the operators, the superintendents, and the people who should be familiar in a general manner with the equipment, what it would do and how it would operate.

The remaining sessions were spent on the details, maintenance problems, repair problems, and was attended by maintenance personnel only.

After the programming was installed, the people knew a lot more about what they were working with, and a refresher course was given. Up to the present we have taken care of the maintenance with our regular maintenance crews. We have no so-called specialists that would handle programming alone. There is a problem which we may have to face in the future on static controls.

Once they are installed and adjusted, we will have some maintenance on all equipment, but it will be a minimum on this type of equipment; the maintenance man may get rusty due to lack of experience.

The card record and storage is a problem. For instance, on the Cleveland mill we have from 20 to 75-in. widths in one-eighth in. increments for each rolling schedule or something like 480 cards. Multiply that by the number of schedules, and there are about 20,000 cards.

Cards have to be stored in a dry, damp-free place and provided to the mill operator as required. It may be that we can work out some kind of a system in which we can program everything except the widths and have the operator schedule the width desired.

In other works, we would reduce our card storage by approximately one in 480. It is a problem that we have to live with at the present time.

As to handling the cards, the recorders handle them in the same manner in which they schedule their steel rollings. They know which slabs are going into the furnaces, and the mill management sends the cards from card storage to the operator pulpits along with his schedules for the day.

The signal from the hot metal detector has caused some maintenance problems due to dirt on the lens. At this location there is steam and scale present. I do not think either of them singularly would be too bad, but together they cause a lot of trouble. For instance, you normally expect to take a cloth and wipe off the face of the hot metal detector, but that is not the case when you have the combination of scale and steam. We have had to scrape it off. We have reduced this problem by the addition of a tube on the lens and a jet of air which keeps the dirt away from the lens. The maintenance personnel clean the lenses weekly. The air required on the tubes is expensive and the periodic cleaning are both items of cost we would like to eliminate if we could find a better detector. We think that these tubes used to detect hot metal in locations other than in the steam-scale area would make a very satisfactory installation.

Regarding the tachometer generators, we have not done anything to compensate for temperature. It is of secondary advantage in the field control circuitry due to the motor field current regulators. ▲

Available Translations

As a service to readers of the *Iron and Steel Engineer* a list of translations from foreign articles is being printed intermittently. Articles selected for this listing will be those thought to be of primary interest to the American steel plant operator. The papers may be obtained from the Cooperative Translation Service, The Iron and Steel Institute, 4 Grosvenor Gardens, London, S. W. 1, England. All correspondence concerning price, ordering and so forth should be directed to the preceding source.

1054 PLOCKINGER, E., and A. RANDAK: "Investigations on Banded Structure in Plain Carbon and Alloy Structural Steels," *Stahl u. Eisen*, 1958, July 24, pp. 1041–1058.

1098 SHEVAKHIN, YU. F.: "The Magnitude of Direction of Axial Forces Acting on the Workpiece in the Cold Reducing of Tubes," *Stal'*, Rolling and Tube Manufacture Supplement, 1958, pp. 295–313.

1142 HILTERHAUS, W.: "Planning Work for the Construction of a Plate Mill," *Stahl u. Eisen*, 1958, Oct. 30, pp. 1525–1535.

1159 DEMENTEV, V. M., and M. M. KOTROVSKY: "Investigation of Ingot Cooling," *Stahl'*, 1958, Sept., pp. 847–851.

1180 GUTHMANN, K.: "The Problem of Clean Air, with Special Reference to the Iron and Steel Industry." I—Measurement; effects; regulations. *Radex Rundschau*, 1958, Jan., pp. 3–30. (*Summary:* This section deals with the general problem of air pollution by dust and gases and then studies the various aspects of contamination of the atmosphere by dust, waste gases and ashes. The special problem of silicosis in steelworks and foundries is discussed, and the article concludes with a description of waste gas cleaning plants, and an outline of the regulations governing air pollution in various countries.)

1183 MATTHAEI, H.: "Oberhausen Plate Mill: Structural Features of a Newly Erected Plate Mill," *Stahl u. Eisen*, 1958, Oct. 30, pp. 1609–1611.

1184 MULLER, H.: "Directions for the Rolling of Alloy Steels," *Stahl u. Eisen*, 1958, Oct. 30, pp. 1611–1613.

1099 BORISOV, S. I.: "The Consumption and Economy of Power in the Production of Tubes by the Automatic and Pilger Processes," *Stal'*, Rolling and Tube Manufacture Supplement, 1958, pp. 314–337.

1116 ZUSMAN, L. L.: "Economic Advantages of Producing Lightened-section Rolled Products," *Stal'*, 1956, Dec., pp. 1099–1103.

1169 KOVAL'CHUK, E. I., and G. I. POPOV: "Life of the Open-hearth Furnace Refractory Lining When Using Oxygen," *Stal'*, 1958, Oct., p. 890.

1174 BOROVKOV, A. N., and E. A. SVETLITSKII: "The Use of Non-changeable Piercer Plugs in a 400-mm Tube Rolling Plant," *Stal'*, 1958, Oct., pp. 926–927.

RECENT

by O. D. Rice,
Vice President and General Manager
and R. W. Ewalt,
Sales Manager,
Rust Furnace Co.,
Pittsburgh, Pa.

. . . . the downtime required for replacing a bar mill reheat furnace was reduced from three months to 23 days by erecting the new furnace on rollers adjacent to the existing furnace . . . . the capacity of strip mill reheat facilities have been increased without using additional floor space . . . .

THE growth of the steel industry in the last few years has brought about many changes in the design and construction of heating equipment for rolling mills. This paper is restricted to three of these: slab reheating for strip and plate mills, bloom reheating for bar mills and soaking pits for blooming mills.

During the recent period of high production a number of plants realized that their heating capacity was inadequate to keep pace with their mill capacity. A strip mill which was serviced by four 60-ton per hr furnaces was found to be able to actually produce in excess of 400 tons per hr. Addition of another furnace would have meant expenditure of several millions of dollars with the removal of adjacent equipment. It was therefore decided to rebuild the existing furnaces for maximum heating capacity.

INCREASING FURNACE PRODUCTION

The original furnaces, Figure 1, were equipped with refractory tile recuperators located underneath the furnace and were 18 ft wide inside and had 80 ft effective heating lengths. These furnaces were of the typical triple-fired design having a soaking zone and top and bottom firing zones. In order to accommodate a longer slab, resulting in increased coil weight, the original 19-in. firebrick walls were replaced above the skid line with a combination of rammed material and insulating block for a total thickness of 11 in. This increased the effective slab length by 1 ft-4 in. to an over-all slab length of 17 ft-4 in. as compared with the original 16 ft.

As shown in Figure 2 a second bottom zone composed of two sets of sidefired burners was installed, and the waste gases from the bottom zones were rerouted so that all the gases went through the existing tile recuperator and existing natural draft stack. This recuperator supplies preheated air at approximately 750 F for the two bottom zones of firing. A metallic recuperator was installed on the top of each furnace with draft provided by an induced draft stack. This recuperator supplies preheated air at approximately 900 F for the top and soaking zone burners.

The construction program called for preliminary work before the shutdown of any furnace. This work consisted of erection of the overhead recuperator, induced draft stack and supporting platforms as well as some combustion air duct work. After this preliminary work was completed, Figure 3, one furnace at a time was shut down; and all of the other permanent changes made to the furnaces. The average downtime per furnace was 15 days. The changes involved in this program resulted in each furnace having a rated capacity of 128 tons per hr, but they have operated many turns averaging considerably more per furnace.

The same problem of coil weight and mill capacity suggested similar changes on another mill. The four furnaces servicing this mill were of typical triple-fired

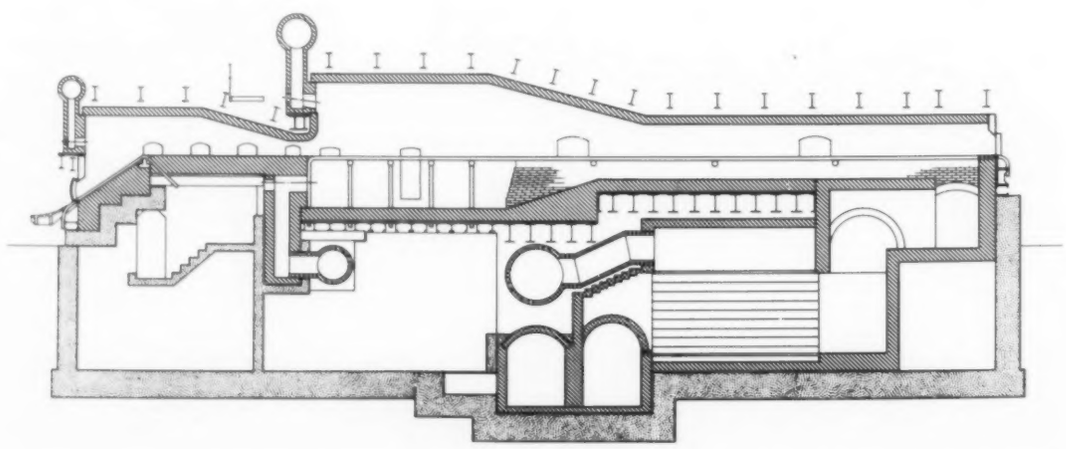


Figure 1 — The capacity of this furnace, one of four heating slabs for a hot strip mill, was increased by replacing the original 19-in. firebrick walls above the skid line with a combination rammed material and insulating block of 11 in. total thickness. The thinner walls permitted heating longer slabs, i.e., the effective length of the furnace was increased.

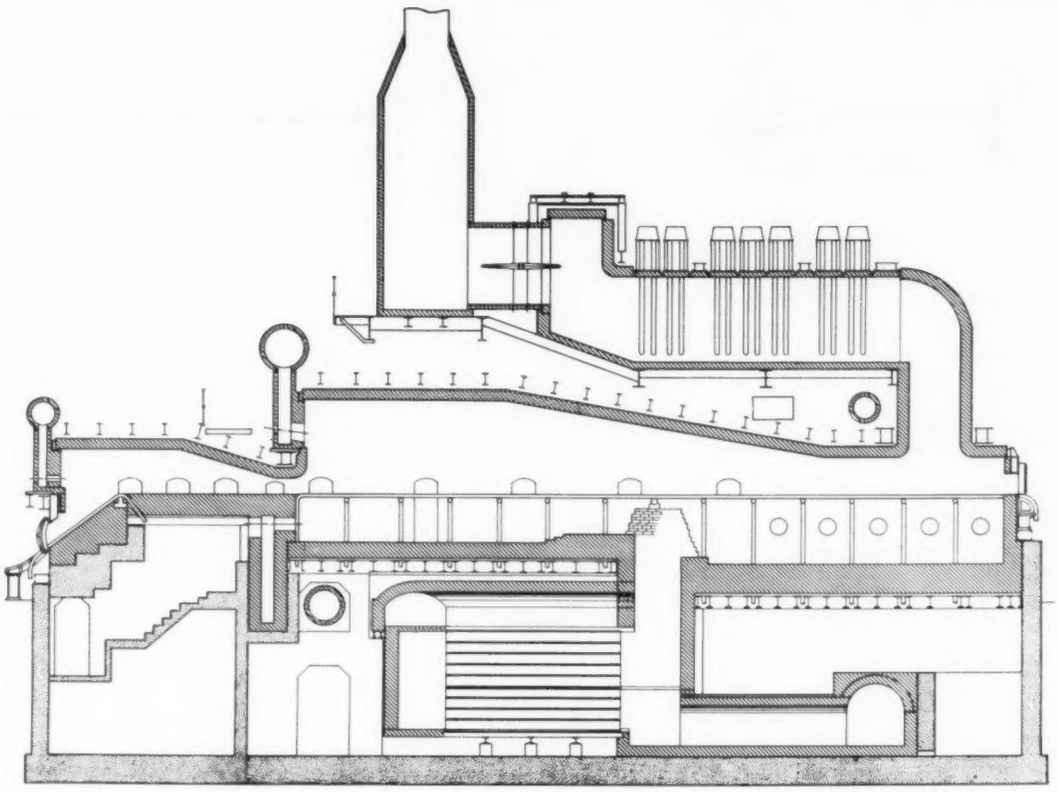


Figure 2 — A second bottom zone composed of two sets of side-fired burners was installed, and the waste gases from the bottom zones were re-routed so that all the gases go through the existing tile recuperator and natural draft stack.

FURNACE INSTALLATIONS

design with refractory tile recuperators located underneath.

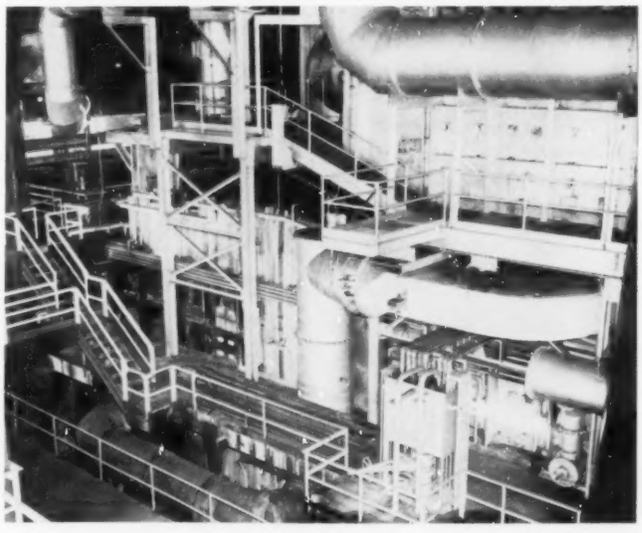
The furnaces, Figure 4, were 24 ft-6 in. wide by 90 ft effective heating length with a conservatively rated capacity of 110 tons per hr each. However, with proper hearth coverage a capacity of 135 tons per hr could be maintained.

These furnaces, Figure 5, were redesigned and rebuilt to include five firing zones consisting of the original soaking zone, the original top and bottom zones though somewhat shortened, and the addition of a third top-firing zone and a second side-fired bottom heating zone located near the charging end.

The side walls of the furnace were changed from 19 in. of refractory brick work to 10 in. of rammed lining and 2 in. of insulating block thus increasing the inside width to 25 ft-2 in. and allowing the slabs to be increased in length from 22 ft to 23 ft-2 in.

Existing tile recuperators beneath the furnaces were left intact, and a new metallic tube type recuperator was installed on top of each furnace. The waste gases were pulled through the tile recuperator by the existing natural draft stack and through the metallic recuperator by a new induced draft stack located on the top of each furnace. These metallic recuperators have their tubes or heating elements suspended from the top, and each consists of an inner and outer tube around which the waste gases are passed. The cold air enters the inner tube at the top and passes downward and then back to the top in the annular space between the inner and outer tube. The preheated air for combustion is drawn

Figure 3 — The overhead recuperator, induced draft stack, supporting platforms and some of the combination air ducts were installed before the furnaces were shut down.



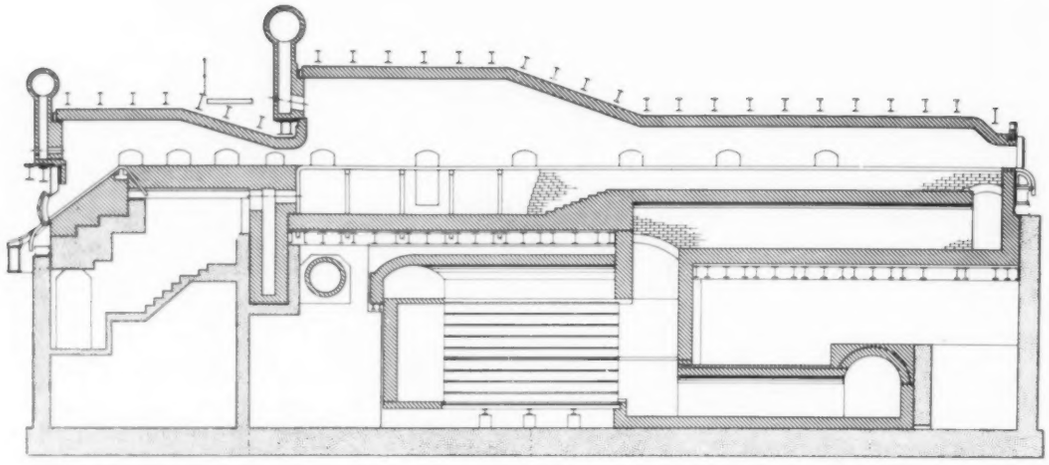


Figure 4 — Proper hearth coverage increased the capacity of this furnace from 110 to 135 tons per hr.

through the tile recuperator by a hot air exhauster and supplies the existing bottom zone and the new side-fired bottom zone. Cold air is blown through the metallic recuperator under pressure and supplies the hot combustion air for the soaking zone and the old and new top zones. The total heat input of the furnaces were changed by adding burners on the new zones and redesigning the burners on the existing zones.

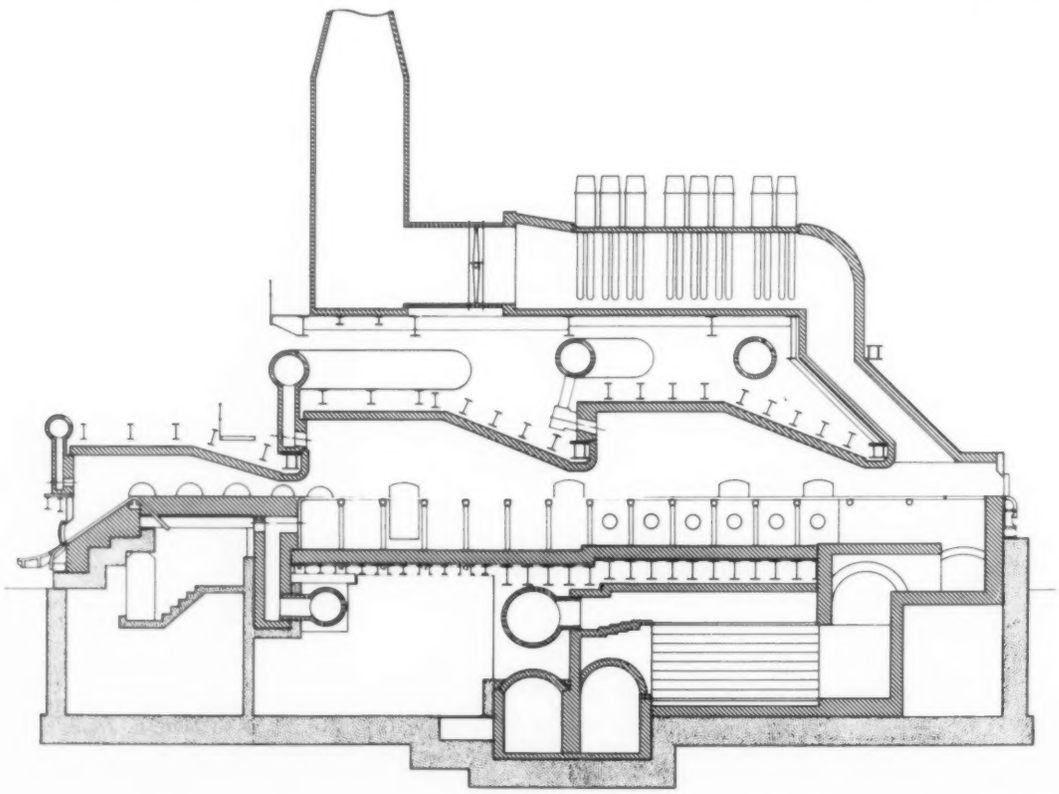
The hearth and side walls of the furnaces were completely dismantled in the heating zones, and the hearth was lowered approximately 2 ft to provide more combustion volume. New refractories were installed for the dismantled portions of the furnaces. Existing hot air piping was altered and additional piping was added for the new zones as depicted in Figure 6. New fuel piping, temperature and combustion control were installed for the two new zones, and equipment on the existing zones was relocated.

The construction program called for the rebuilding of one furnace at a time in order to eliminate interference with the operation of the mill. It was again possible to accomplish preliminary work similar to that described previously before shutting down any of the existing furnaces. The average downtime for each furnace during the construction program was approximately 18 days. Unfortunately this reconstruction was completed just before the decrease in steel production so that long range production figures are not available. However, it is apparent that heating rates in excess of 200 lb per sq ft per hr can be sustained.

At another plant a 14-in. bar mill was served by a furnace which was single zone top-fired only. This furnace was required to reheat blooms up to 6⅝-in. square. It had an optimum capacity of 60 tons per hr while the mill was capable of rolling in excess of 125 tons per hr. In the interest of quality and low reconditioning cost it was decided to build a three-zone furnace, Figure 7, having a rated capacity of 125 tons per hr with a peak of 150 tons per hr. In order to minimize mill outage as much as possible, the furnace was built behind the existing furnace on rollers resting on wide-flanged beams which in turn rested on concrete foundations.

The new furnace is 32 ft wide inside by 73 ft effective

Figure 5 — The furnace of Figure 4 was redesigned and rebuilt to include a third top-fired and a second side-fired bottom heating zone.



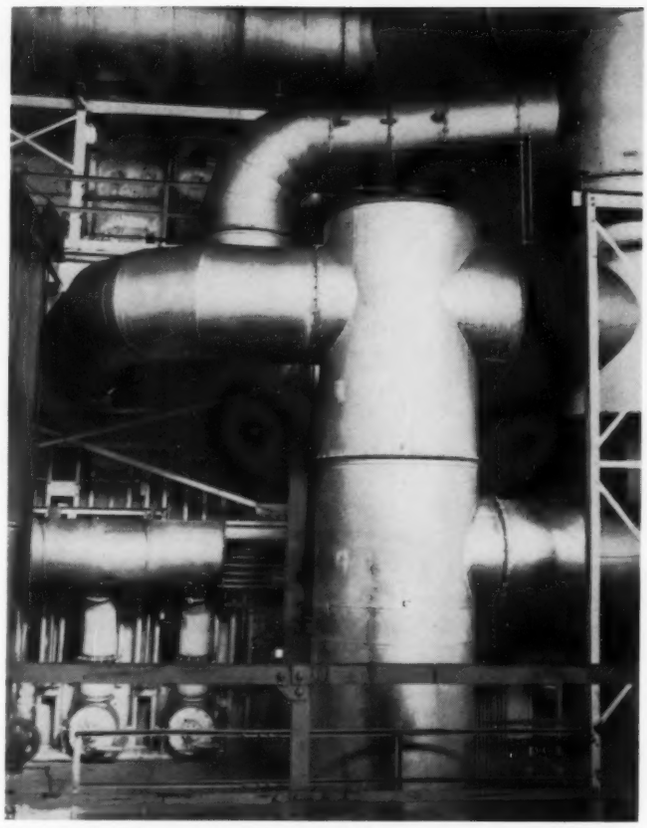


Figure 6 — The existing hot air piping of the furnace shown in Figure 4 was altered, and additional piping was added for the new zones.

heating length and is end-charged and side-discharged. Since the furnace is required to heat 8-in. square blooms 30 ft long, the blooms are carried through the heating zone on eight double extra heavy water-cooled skid pipes. They then ride over the chrome brick soaking hearth on eight sectionalized carbon steel dry skids 6 ft-6 in. long imbedded in the hearth and staggered to reduce water-cooled skid marks. The side walls of the furnace, Figure 8, are 19 in. thick. The arch is of suspended construction 11½ in. thick. The furnace is fired with 36 combination coke oven, natural gas or oil, hot air burners. The air for combustion is supplied to these burners from a metallic tube type recuperator located alongside the furnace. The recuperator consists of two units, each having a shell diameter of 7 ft-9 in., and is 11 ft-6 in. high. Each shell is composed of a bundle of tubes through which the waste gases pass. The cold air is forced into the shell at the top and is passed back and forth around the tubes by means of baffles and exits at the bottom. It is designed to preheat the air to 700 F. The waste gases are removed from the furnace and recuperator by means of an induced draft stack. The furnace is equipped with temperature control, fuel-air ratio control and automatic furnace pressure control.

The furnace, Figure 9, was erected in the bloom storage yard 97 ft-6 in. in back of and slightly off-center of the existing furnace. It was constructed on 2¾-in. rollers resting on 12-in. wide-flanged beams. A portion of the furnace, approximately 13 ft long, was not constructed at this time because of the space limitations. While the new furnace was being built and the old furnace operating, the new vertical tubular type recuperator and the induced-draft stack were installed along with as much of the stack flue and air piping, which was to connect with the furnace, as possible. At the time of the mill shutdown the old furnace was demolished, foundation changes were made and the new furnace rolled into place. Great care was taken in properly placing

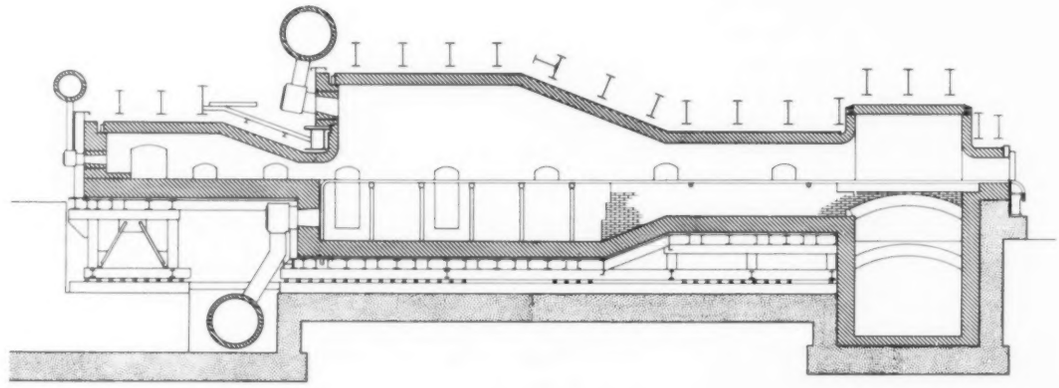


Figure 7 — In order to minimize mill outage this furnace was built behind the existing furnace on rollers.

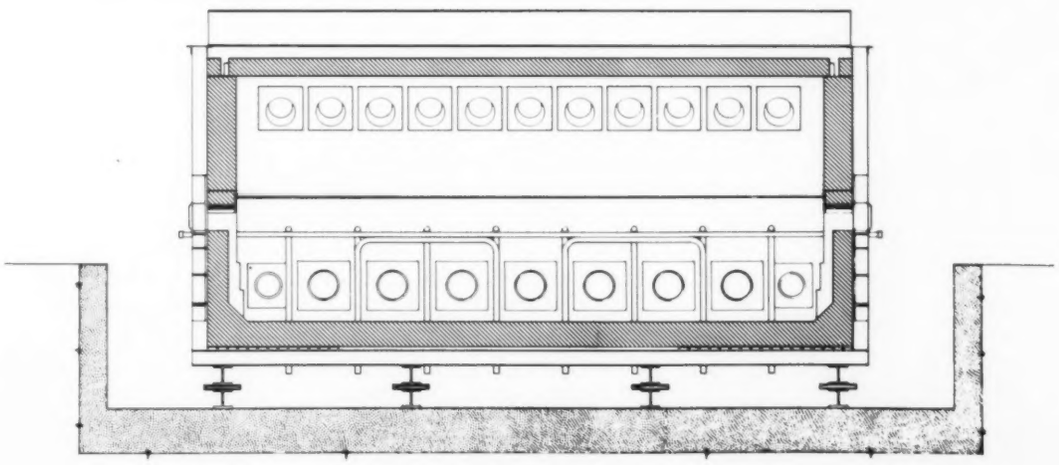


Figure 8 — The side walls of the furnace shown in Figure 7 are 19 in. thick, and the arch is of suspended construction.

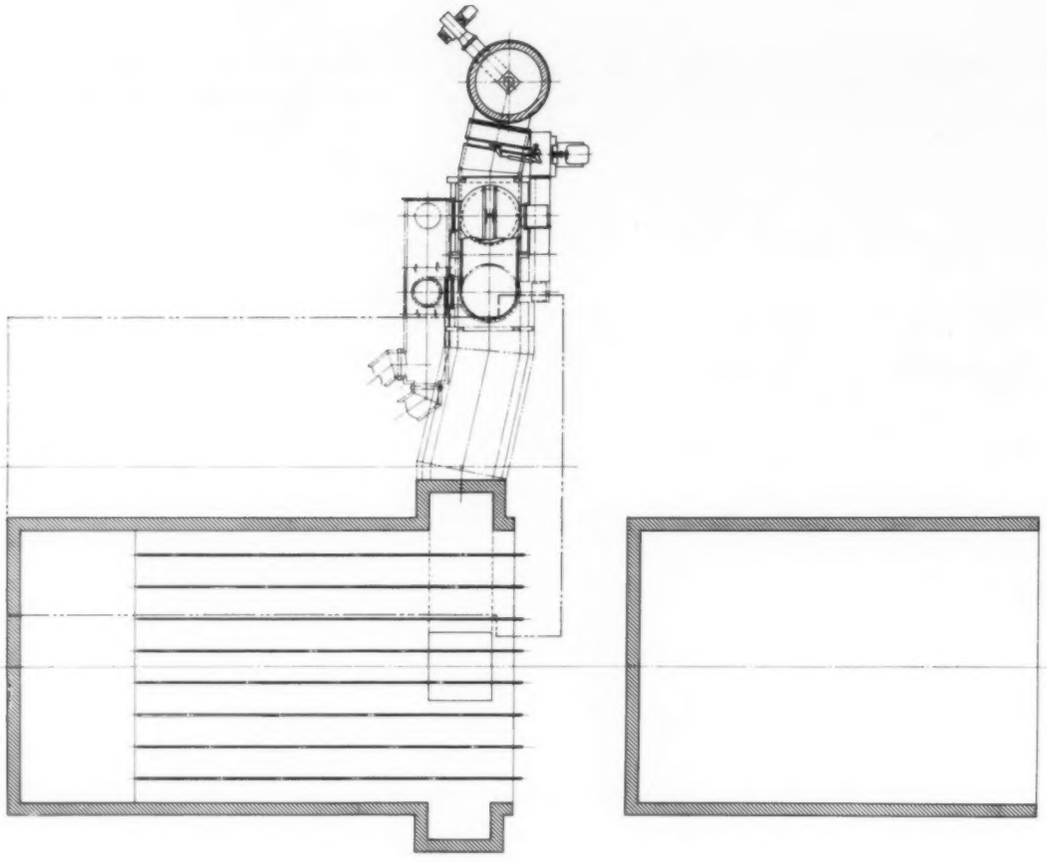


Figure 9 — The furnace of Figure 7 was erected behind and slightly off-center of the existing furnace.

$2\frac{3}{4}$-in. rollers on which the furnace was built to insure that they would stay straight until a great enough load was on them. Two 250-ton hydraulic jacks were used to move the furnace as shown in Figure 10. They were piped so that they could be operated simultaneously from one control station. Since the greatest load would be on the center two beams, the jacks were placed at these two points.

Continuous sightings were made by field engineers during the move in order to insure proper alinement of the furnace. The weight of the furnace being rolled into place was approximately 1700 tons. After the furnace was in place, the beams and rollers were grouted in, the flues joined and the charging end completed. Previous to this time, the panel board control piping and fuel piping were completed to a point adjacent to the final location of the furnace. Impulse piping, in particular, was tagged so that it could be quickly coupled with the piping on the furnace.

Figure 10 — Hydraulic jacks were used to move the furnace of Figure 7 into its final position.

The physical movement of the furnace required 23 hr. Under normal construction practice the mill would have been out of service four months. Under this schedule the entire installation was completed, and the new furnace placed in operation with a mill downtime of 23 days, during which time extensive changes were made to the mill.

After the furnace was in place, field checks revealed that it was on the exact longitudinal centerline and off the centerline of the mill $\frac{1}{8}$ in. The furnace erection was completed and the furnace ready to roll steel before mill changes were completed.

SOAKING PITS

Recently a new slabbing mill was installed where the low-Btu fuel indicated the use of regenerative soaking pits.

Regenerative soaking pits were in common use throughout the steel industry for many years before any attempt was made to perfect their design. Later the recuperative soaking pit came into existence. Since operators in the steel industry were not entirely satisfied with the heating obtained in the regenerative pit, a large number of recuperative soaking pits were installed; and it appeared that the use of the regenerative pits would decline rapidly. In time imperfections in the design of the recuperative soaking pits become apparent, and early in the 1930's regenerative pits were modern-

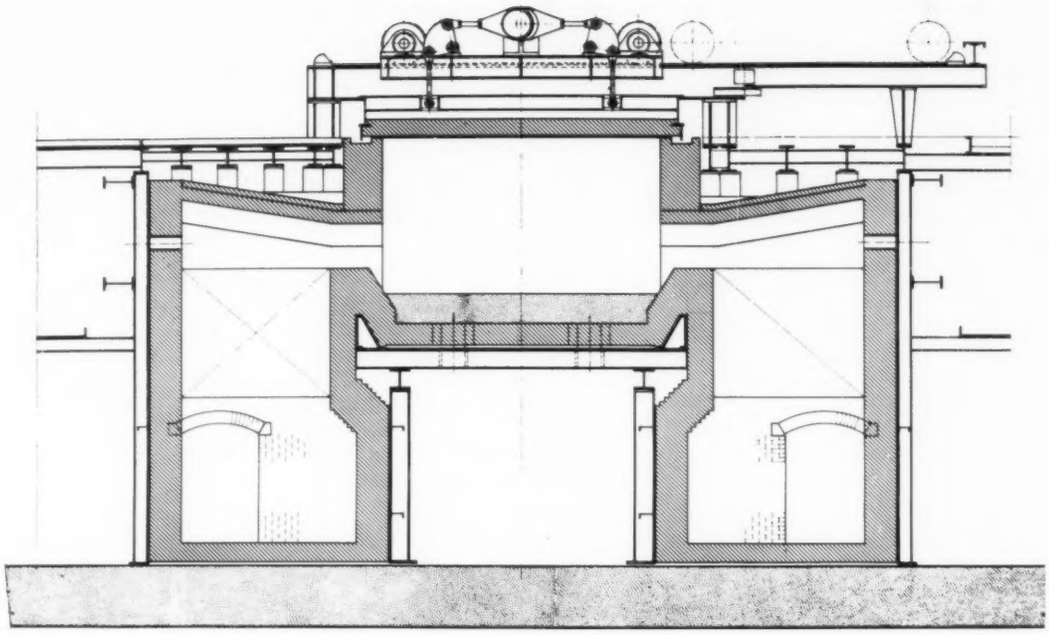


Figure 11 — A modern island layout type soaking pit.

ized. The modernization included the following improvements:

1. Each hole of the battery was constructed so as to operate as an independent unit.
2. Tight closing, reversing valves with positive seals were added for each hole.
3. Automatic means were provided for reversing the flows of the fuel, air and waste gases for each hole.
4. Automatic temperature, combustion and furnace pressure controls were added.
5. Automatic controls for fuel and air shutoff valves and pit dampening actuated by cover removal were added.

Since these initial refinements many more have been made, and it is felt that regenerative pits are recognized by operators for the following advantages:

1. Utilization of low-Btu fuels.
2. High quality heating with absence of washing with all types of gaseous fuels.
3. Exceptionally high heating rates.

The example, Figure 11, is of the island layout type consisting of eight batteries of two holes each. The ingot size dictated that the holes be 16 ft by 20 ft and 10 ft-5 in. deep including an allowance of 15 in. for a coke breeze bottom.

The pit covers are of the suspended type, and each cover has its own unit type mechanism for lifting and removing the cover (Figures 12 and 13). These covers can be operated from one of two stations on the control platform in the building lean-to or from the work platform at each pit.

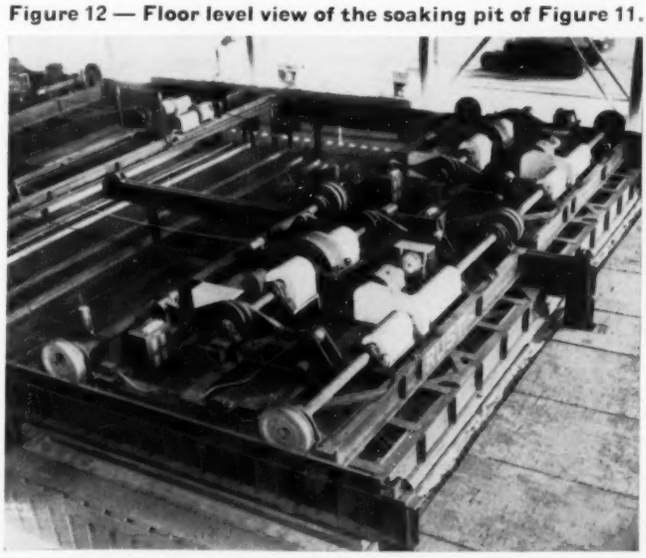
The pits are cross-fired, across the 16-ft dimension. Relatively small checkers were installed integral with the pits, and the remaining checkers were installed in the base of the induced-draft stacks located in the lean-to. There are two induced-draft stacks per hole, and reversal is accomplished by means of an Isley system consisting of combustion air fans, ejection air fans and throat valves.

The checker system was designed to preheat combustion air to approximately 2000 F. Each hole of the pits, the induced draft stacks and the reversal systems are designed to handle 35,000,000 Btu per hr input of 106-Btu per cu ft mixed coke oven and blast furnace gas. When heating 3½ hr track-time steel a fuel rate of 500,000 Btu per ton is anticipated, and 1,100,000 Btu per ton is anticipated on cold steel.

The automatic temperature control is of the on-off type which provides firing with full gas flow and operates over a temperature differential of 30 F. The maximum opening of fuel flow and air flow control valves may be adjusted manually from the panel board for each hole. Each hole also incorporates an automatic furnace pressure control which dampens the pit.

The entire soaking pit installation of 16 holes, Figure 14, is reversed in sequence, hole by hole at a predetermined time interval which is adjustable. An electric master timer actuates the electrical reversal system for each hole. However, the furnace pressure, air flow and fuel flow valves do not physically move until the temperature control indicates to a relay

Figure 12 — Floor level view of the soaking pit of Figure 11.



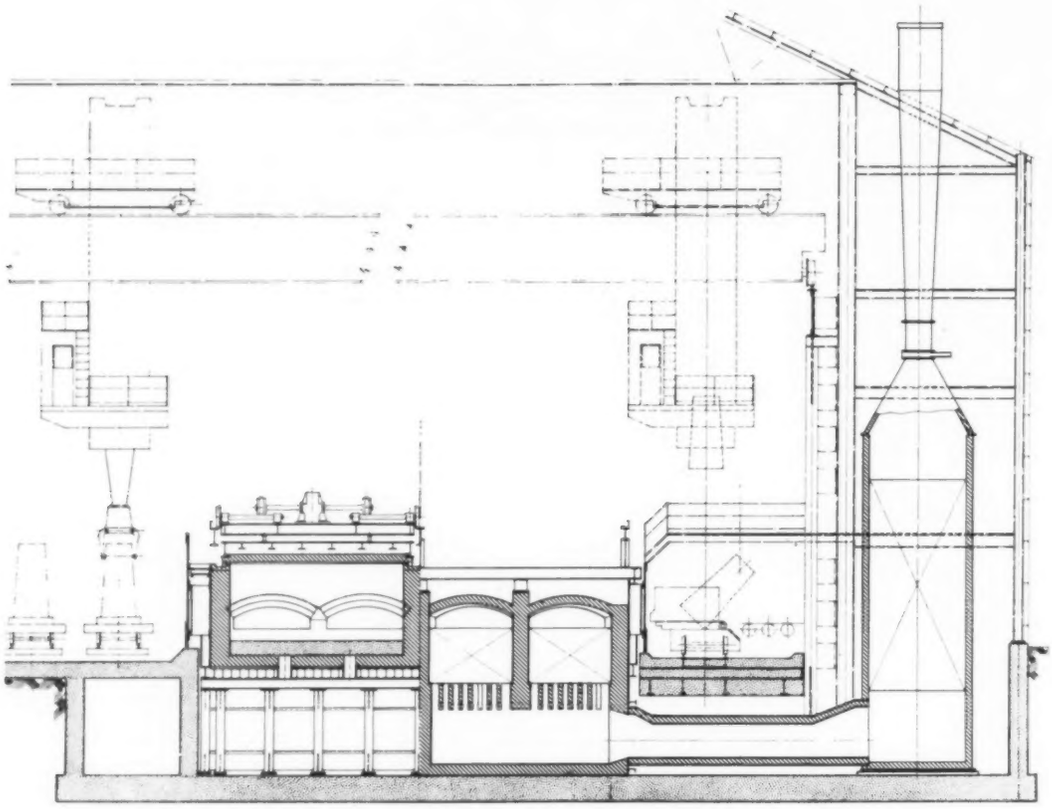


Figure 13 — Each cover of the soaking pits shown in Figure 11 has its own unit for lifting and removing.

system that it is about to call for fuel.

By virtue of high-temperature, preheated air the heating is very rapid; and due to the benefits of the large volumes occasioned by the use of low calorific value fuel the heating is excellent with a high degree of uniformity from top to bottom and with a complete absence of washing.

In conclusion, it may be definitely stated that the trend in heating equipment is toward improvement of heating quality and obtaining maximum heating capacity in available space at a minimum over-all cost. This trend should result in a higher yield in the finished material thus benefiting the ultimate consumer by a better and less expensive product.

Discussion

PRESENTED BY

HENRY S. HALL, Assistant Manager, Combustion Control Dept., Morgan Construction Co., Worcester, Mass.

HEINZ A. KUHNE and THOMAS E. DIXON, Vice Presidents, Griscom-Russell-Schack Co., Inc., Pittsburgh, Pa.

R. W. EWALT, Sales Manager, Rust Furnace Co., Pittsburgh, Pa.

H. H. DINNEEN, Chief Engineer, Rust Furnace Co., Pittsburgh, Pa.

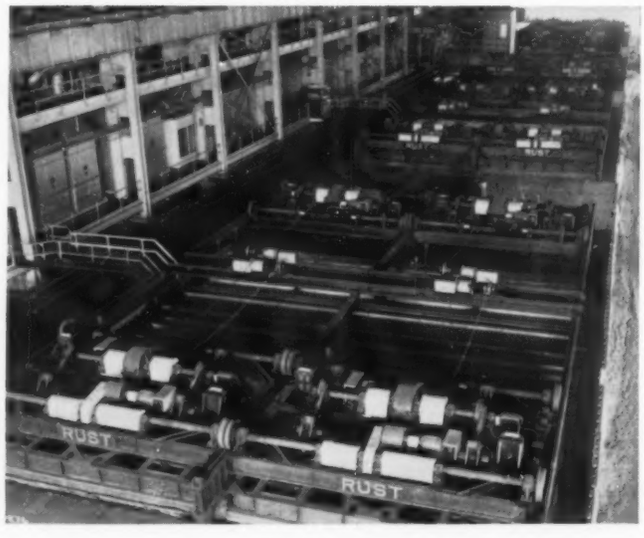
THOMAS L. NABORS, Chief Combustion Engineer, Southern District, Republic Steel Corp., Gadsden, Ala.

Henry S. Hall: We supply some of the ejectors on continuous furnaces and soaking pits. The ejectors, of course, are a straightforward proposition and are the same as have recently been used on quite a few continuous heating furnaces for slab mills, bar mills, rod mills, etc.

The systems on the soaking pits, however, have only recently been installed in a number of plants. Each installation has been somewhat different, but they have all had one purpose, to increase the temperature of the combustion air.

At first it was not too easy to convince someone that checkers could be built upside down, i.e., the hot gases enter the bottom of the checkers and leave at the top which, of course, is backward to the normal design. However, we have used secondary checkers on open hearths for quite a number of years. The temperatures entering the bases of these checkers has gradually in-

Figure 14 — The 16-hole soaking pit installation is automatically reversed hole-by-hole.



creased in various installations, and at no time have we ever had any failure of the rider arches or rider walls.

We then made an installation on a soaking pit in which no primary checkers were used whatsoever, and all of the checkers were placed in the bases of the ejectors. The entering gas temperature at this point is in the neighborhood of 2100 to 2200 F and at the present time has been in service for over two years and showing no deterioration whatsoever.

In the soaking pits shown in this paper are small primary checkers which do reduce the temperature of the flue gases to around 1800 to 1900 F, and the secondary checkers reduce this to a final flue gas temperature of approximately 800 F.

The fuel used in this instance is a mixture of blast furnace and coke oven gas of about 106 Btu per cu ft. We have in operation soaking pits using straight blast furnace gas of 88 Btu per cu ft, 106, 117 and 120 Btu, on up to straight coke oven gas, straight natural gas and Bunker C oil.

The modern regenerative soaking pit has come a very long way from the old time regenerative pit.

Heinz A. Kuhne and Thomas E. Dixon: With reference to the split recuperative furnace design we would like the authors to elaborate somewhat on the method used to control furnace pressure. Furthermore, because of their influence on recuperator design, it would also be of value to know what flue gas temperatures entering the recuperators have been recorded, and in what proportion the waste gas volumes appear to divide.

Turning now to the regenerative soaking pit design and the utilization of lower-Btu fuels, a great deal depends upon local fuel balances so that the use of blast furnace gas may well become more interesting to the steel industry as richer fuels increase in cost. We realize, of course, that in the particular instance cited the furnace builder had to use dirty gas making regenerative heating almost mandatory.

With the increased use of beneficiated ore, blast furnace operators are striving for greater stove preheats. This requires a larger stove heating surface. Many conversions have already been made from basket weave checker arrangements to more intricate designs with inherently greater surface area provided at the expense of limiting the free area for gas passage. To avoid fouling of these passages by dust we find electrical dust precipitators being added to many blast furnaces during rebuilds; new furnaces are seldom built without these precipitators. Thus, in the future there may be much more clean blast furnace gas available as a metallurgical fuel.

It is well known that because of its low calorific value, the air preheat must be very high with blast furnace gas if one is to achieve flame temperatures suitable for use in soaking pits. At the air preheat of 2000 F mentioned by the authors, the theoretical flame temperature is 3470 F for a 100-Btu gas. A preheat of 2000 F approaches very closely the average flue gas temperature one can expect over a soaking pit heating cycle. Attaining such a preheat calls for a perfectly tight and well insulated flue gas system, and dirt must not be allowed to upset heat transfer rates in the checker chambers. This theoretical flame temperature, of course, is not available for heating steel and must be reduced by a factor referred to as the pyrometric efficiency of the burner or the burner coefficient. This coefficient depends to a great extent on the magnitude of the contact area between fuel and air. There can be little doubt that the factor is higher in the case of an intensive mixing burner than in a regenerative system where, during part of the cycle, the burner ports also constitute waste gas offtakes. If we use a coefficient of 0.75, which may be on the generous side, then the effective flame temperature with 2000 F air preheat would be 2620 F.

Let us now consider a recuperative combustion system in which both air and blast furnace gas are preheated. Let us say, for example, air is available at the burner at 1200 F and gas at 800 F. Both figures are relatively modest compared with the latest results available. Since one degree F gas preheat is equivalent to approximately 1.2 F air preheat, this arrangement is equivalent to 2200 F air preheat with cold gas and results in a theoretical flame temperature of 3550 F. If one multiplies this by the coefficient for a well designed burner, namely, 0.90, an effective flame temperature of 3200 F, or nearly 600 F more results. The extra temperature head thus made available should enable one to bring a pit up to temperature more rapidly, particularly in cases where high percentages of cold charge suddenly arise.

The desired recuperator preheat temperatures can be arranged to occur at 1800 F so that full preheat is available when it is most needed, i.e., at the commencement of the heating cycle. The combination of a metal recuperator and a well designed burner, enables one to use a high-pressure combustion system in which rapid mixing and higher flame temperatures can be achieved, and where large masses of combustion products can be caused to rotate in the pit.

Turning now to physical arrangements for recuperative heating, one eliminates the reversing mechanism and it is perfectly feasible to accommodate the entire recuperative system in a tower arrangement in no more space than that required by a checker-lined stack. The long connecting flues, which are often used to contain further checkers, can be shortened and simplified.

R. W. Ewalt: In the first example, the four-zone furnace, the flue gas temperature entering the recuperator is approximately 1900 F; and in the five-zone furnace it is about 2100 F.

H. H. Dinneen: The control of draft on these furnaces with the split draft system presented a rather interesting problem. It was finally solved by using two regulators, one which might be called a normal furnace pressure regulator and the other a ratio type furnace pressure regulator. The furnace pressure is connected to the regulator actuating the damper for the top recuperator.

The other regulator is hooked up in such a manner that the ratio of flow of gases through the bottom recuperator is proportioned to the flow through the top recuperator. The impulse system of the regulator is like a conventional ratio regulator. So, as the differential across the top recuperator increases, the bottom damper opens to increase the flow through the bottom recuperator. Since the air from the top recuperator goes to the burners above the steel, all the gases on the topside of the steel go upward, and the gases on the bottomside of the steel go downward. The only way we had of determining this was by observation of temperatures

obtained and bringing them somewhere near what was expected.

Thomas L. Nabors: Because the initial cost of a new installation per ton of production is almost prohibitive, it is apparent that the steel industry will more and more demand increased production through modernization of existing furnaces. This seems to indicate such a trend. I would like to ask Mr. Dinneen if they are offering or making any provisions in the design of proposed new installations for readily modernizing them for increased capacity.

One other thing I would like to comment on is this business of erecting furnaces off-site. It seems that this engineering feat is an answer to an operator's dream when production must be maintained at a high rate. Through the combined engineering skills of buyer and supplier such feats as this often can be accomplished to the best advantage of the industry as a whole.

H. H. Dinneen: Are we making any provisions in current furnace designs so they will be easier to modernize in the future? By modernizing you mean increasing the capacity because that is the usual job we are called on to do. The answer to that is: yes, where we can. In rebuilding as many furnaces as we have over the past ten years, many problems have cropped up in older designs of furnaces, which created great problems in rebuilding them.

The usual problem encountered when rebuilding one of a group of, say slab furnaces is to keep all furnaces in service except the one being rebuilt. Many furnace installations of this type have utility services, electrical starters, electrical conduit, water mains, flues, stacks and other pertinent items located remotely from the furnace they serve. Maintenance of these services while remodeling an adjacent furnace is a problem. We now try to keep all such services and auxiliary equipment close to the furnace they serve.

Other than the above precautions, no other provisions for future capacity increases are usually provided. ▲

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Compania de Acero del Pacifico, Chile—Its Inception and Growth

by Juan Zapata, Vice President
Compania de Acero del Pacifico, New York Office, New York, N.Y.

The design of Chile's first steel mill, which was dictated by market considerations, has resulted in a profit-making plant, which has been expanded three times since it went into operation in 1950 . . . . it has attracted many steel-consuming manufacturers to Chile.

DURING the year 1939 the Chilean government created the Corporacion de Fomento de la Produccion (CORFO) (literally Production Promotion Corp.), an instrument of the government to foster the industrialization of Chile. This agency established a comprehensive economic development plan that included hydroelectric power, oil development and refining, and steel manufacture.

Preliminary work on a steel mill project was started in 1943. In 1946 a Chilean stock company, Compania de Acero del Pacifico (abbreviated CAP) was organized to build and operate the steel plant. The company was founded with capital contributions by government agencies and investments by private enterprise, the authorized capital at the time being $15,000,000. Of this stock 53.3 per cent was subscribed to by private investors and 46.7 per cent by the Fomento Corp. and other government agencies of the Republic of Chile. Among the private stockholders are American firms such as Anaconda Copper Co., Kennecott Copper Corp., W. R. Grace and Co., and Koppers Co. of Pittsburgh.

PRELIMINARY STUDIES AND ORGANIZATION

In Chile before the construction of the Huachipato plant the consumer of iron and steel products had to rely largely on imports. Domestic production was small and could only partially meet the national demand. In the years immediately preceding World War II the average annual consumption of steel products amounts to 141,000 tons of which 124,000 tons were imported. This does not include the steel imports of the large mining interests, which averaged 30,000 tons per year during that period. Domestic production at that time amounted to approximately 17,000 tons per year (chiefly reinforcing steel bars) produced at several small plants located in the Santiago area and in Corral.

The drastic curtailment of steel imports during the war years gave impetus to the idea of establishing an integrated steel plant in Chile. The availability of good grade iron ores and coal, already being mined commercially in the country, as well as an abundance of hydroelectric power added greatly to the possible merit of such a project. Preliminary studies, made in collaboration with American engineers, confirmed that there existed in Chile sufficient raw materials of proper quality, electric power, transportation facilities, etc., to make the establishment of an integrated steel industry physically practical. Preliminary studies were also made regarding the technical and financial aspects of such an enterprise. A report of these findings was submitted to the responsible government authorities.

In 1942 the government appointed a Steel Commission to review CORFO's findings. This commission was comprised of managers of established industries, utilities, and responsible government bureaus together with representatives of CORFO. Their duty was to study CORFO's preliminary report and submit a final report on the feasibility of proceeding with a steel project. The commission's report, submitted December 15, 1942, was favorable and CORFO was authorized to proceed with the technical development of an integrated steel plant to supply the needs of the country.

The Steel Committee obtained the passage of a law granting the steel industry guarantees and privileges

which facilitated the financing of the large capital investment required and assured the industry of an unhindered development. This law, No. 7896, went into effect on October 2, 1944.

FINANCING OF THE PROJECT

The initial cost of the project was in the neighborhood of $80,000,000. This sum was obtained as follows: $15,000,000 with the equity paid capital; $48,000,000 from the Export-Import Bank of Washington; $10,000,000 in CAP debentures from the Central Bank of Chile; $1,096,700 in debentures subscribed by the Amortization Bank and turned into its Chilean currency equivalent; $2,881,000 furnished by the Fomento Corp. against CAP debentures; and $3,022,300 dollars credited in favor of the company by various North American suppliers of equipment.

PLANT SITE

The site selected by the Steel Committee for the plant was San Vicente Bay, near the cities of Concepcion and Talcahuano and some 300 miles south of Santiago, capital of Chile. This site incorporated a deep sea water harbor; it permitted electric power from the Abanico plant located in the Andes to be readily obtained; and it made possible the provision of water from the Bio-Bio River, which passes nearby on its way to the sea. The local name of the plant is Huachipato. The proximity of cities like Concepcion and Talcahuano provided an adequate supply of labor and minimized transportation and housing problems.

SURVEY AND QUALITY OF RAW MATERIALS

Coal—During 1946 an extensive investigation of the source and quality of raw materials was conducted. However, prior to this date—actually in 1943—tests of Chilean commercial coals, from the Lota and Schwager mines, had been conducted in this country to ascertain the quality of coke they would yield. These tests showed that metallurgical coke of satisfactory quality could be obtained from varying mixtures of Chilean and U. S. coals.

Average characteristics of the Chilean coking coal have been as follows:

Volatile matter	40	−43	per cent
Ash	5	−10	per cent
Sulphur	0.75	−1.7	per cent
Fixed carbon	48	−53	per cent

The Lota and Schwager mines are 30 and 26 kilometers respectively from the steel works, and coal is transported in CAP's own trains on state railways to the plant. A mixture of 65 per cent Chilean and 35 per cent U. S. coal is used at present yielding a coke of the following characteristics:

Ash	8.4	per cent
Sulphur	0.81	per cent
Stability factor	44.9	per cent

Iron ore—The 1946 extensive investigations by the Fomento Corp. of the local sources of principal raw materials confirmed previous surveys indicating that suitable raw materials could be obtained in Chile.

A contract was entered into with the Bethlehem Chile Iron Mines Co. for supply of iron ore from their El Tofo mine, which had been in operation for many years. Iron ore was loaded at Cruz Grande, some 500 miles from the plant. Ore from this source was utilized from the beginning of operations in 1950 until this mine was exhausted in 1955. Prior to this time, however, under joint agreement with Bethlehem the El Romeral deposit, located approximately 17 miles northeast of LaSerena and 20 miles south of El Tofo, was developed. CAP is currently being supplied by this mine. Ore from this source is expected to take care of the normal requirements of CAP for the next 20 years. Ore is loaded at Guayacan, 25 miles from El Romeral, where special pier and mechanical loading facilities are being used. El Romeral ore has the following average analysis:

Fe	60.5	per cent
SiO_2	8.5	per cent
P	0.25	per cent
Fines	28.0	per cent

The total raw material cost level which will permit this company to produce steel at competitive prices presumes: (a) an extensive reserve of high quality ore is available to justify the costly installations and equipment required for large scale, mechanized mining and, (b) that it be favorably located so as to permit economic inland and maritime shipments. Algarrobo Mine, about 50 miles northeast from the port of Huasco in northern Chile and some 510 nautical miles from San Vicente, fulfills these requirements. Algarrobo has an "in sight" reserve of about 50,000,000 metric tons of ore and a "probable" reserve of 75,000,000 tons. This source will ensure CAP of an adequate supply for two blast furnace operations for the next 50 years.

Limestone—After studies of all possible sources of limestone CAP decided to develop the deposits on Guarello Island on the Madre de Dios Archipielago just north of the Straits of Magellan and about 900 nautical miles from the plant. CAP maintains its own organization in that faraway location and has an open pit mining operation. The high calcium carbonate content, in the level of 99.2 per cent, indicates the unusual purity of this material.

Dolomite—Dolomite had to be added to the blast furnace in the beginning to increase magnesia content in order to maintain the correct desulphurizing slag in the furnace.

Dolomite was also mined by CAP's own organization from the El Maule deposit, some 150 miles from the plant. The dolomite from El Maule, due to its high silica content was used only in the blast furnace. With the use of El Romeral iron ore, the dolomite use in the blast furnace was discontinued. Open hearth requirements of low silica dolomite are imported from the Republic of Uruguay, some 4000 miles from the plant on the east coast of South America.

TRANSPORT

At the time, contracts for transport of raw materials were arrived at with the C.S.A.V. (Compania Sudamericana de Vapores) Chilean Line. This company built two special ore carriers of 8000 metric tons each, the SS Tofo and the SS Romeral. To lower the cost of trans-

port they are being replaced now by two 17,050-metric-ton-displacement ships of higher speed and larger capacity.

A special agreement with the Chilean State Railways was also reached for the bulk transportation of the finished products. That entailed new installations on their part at the neighboring railway junction.

CONSTRUCTION OF FACILITIES AND THEIR CAPACITIES

Construction of the steel plant was actively started about the end of 1947 with initial operation starting November, 1949, and full operation in June, 1950. The pier installation was completed in November, 1948, and greatly facilitated the incoming of heavy equipment and materials necessary for construction. Emphasis was also placed on early completion of the maintenance shops in order to use these facilities for plant construction purposes.

The plate, sheet and tinplate mills were placed in operation in 1949. During their early operation imported semi-finished material were used. Coke ovens were in production in April, 1950. The merchant mill started in May, 1950, using imported billets. The blast furnace was blown in on June 1, 1950, marking the start of general plant operations, and the first cast was obtained June 3, 1950. The steel production dept. started operations in June, 1950, followed by the blooming mill in August, 1950.

The main facilities of the plant at the time were as follows:

Pier, 890 ft long x 70 ft wide.
Unloading tower of 5½ metric ton capacity for unloading iron ore, coal and limestone.
Raw material conveying and bedding system
Coke ovens consisting of 57 under-jet combination type ovens each with a capacity of 576 cu ft or 14.4 net tons of coal.
Tar and ammonia removal plant consisting of three primary coolers, exhauster house, two ammonia towers.
Benzol plant.
Tar plant of capacity 10,000 gal.
Sulphuric acid plant rated at ten metric tons per day of 98 per cent sulphuric acid.
Boiler plant, two 50,000 lb per hr boilers at 250 lb psi.
Standby generator, 2500 kw, 0.8 power factor, 3125 kva and impulse turbine for 250-psi 100-F superheat designed for quick starting.
Blast furnace with hearth diameter of 20 ft-9 in.
Two motor driven blowers each having a capacity of 50,000 cfm at 30-psi discharge pressure and installed to blow the furnace.
Three hot blast stoves, 21 ft in diameter x 94 ft high having capacity of 1500 F straight-line temperature for 50,000 cfm of blast.
Six 80-net ton hot metal cars deliver hot metal to the steel production dept. and the pig casting machine.
The pig casting machine with a capacity of 50 metric tons per hr of 40-lb pigs.
The bessemer converter, an acid-lined, 15-metric ton unit.
Two open hearth furnaces, each with 75-ton capacity; No. 1 equipped with a waste heat boiler with a capacity of approximately 8000 lb per hr of 250-psi steam.
Skull cracking facilities
Soaking pits consist of four bottom-fired recuperative furnaces each with a holding capacity of approximately 65 metric tons. Impact ingot stripping facilities are located in the soaking pit building.
32 x 78-in. 2-high reversing blooming mill to roll ingots 14½ x 14½; 21 x 23 and 18 x 28-in.
26 x 68 and 18 x 24-in. billet and sheet bar mill
18-in. merchant and rod mill 3-high breakdown, vertical edger 22 in. diam underhung rollers consisting of:
five 2-high 14-in. mill stands.
two 2-high 2-in. mill stands.
two 2-high 12-in. mill stands.
two 2-high 10-in. mill stands.
10-in. continuous rod mill comprised of six stands, maximum speed 3400 fpm, for No. 5 rods. Cold shear is an open-throat type with 150-ton capacity.
One 3 high breakdown sheet and tinplate mill.
Three 2-high finishing sheet and tinplate mills.
One 2-high plate roughing mill.
One 2-high plate finishing mill
Finished units include shearing, pickling, annealing, normalizing, cold rolling, galvanizing and tinning facilities.
Pipe mill capacity to form 12-in. outside diameter pipe of 0.375-in. wall thickness up to 35 ft long.
Maintenance shop.
General stores and warehouse.
Metallurgical and chemical laboratories

GROWTH

Shown in Table I are the production increases between 1951 and 1957. In addition to the installation of the increased facilities in 1951, this increase can be attributed to a combination of other factors, the adoption of the duplex process in the Steel production dept., the increased capacity of the two original open hearth furnaces from 75 to 100 tons; and the improved efficiency of the personnel.

IMPROVEMENT PROGRAM—1951

Ore bridge and raw material bedding and conveying system extensions.
Blast furnace stove No. 4.
Additional battery of 13 coke ovens.
Sintering plant—250 metric tons per day.
Open hearth furnace No. 3—100 metric tons.
Bessemer converter No. 2 (no additional blowing equipment).
Two soaking pits.
Three hand finishing mills and additional auxiliary equipment thereto.
Galvanizing line No. 2.
Tinning line No. 4.
Black pickler.
Ingot stripper.
Improved skull cracking facilities.

With these factors steel ingot capacity was increased from 236,000 metric tons as originally planned to more than 360,000 metric tons. In fact the production for 1957 was 388,000 tons of ingot.

Tables I and II show the production and capacity

TABLE I
Annual Production (Metric Tons)

Product	1951	1952	1953	1954	1955	1956	1957
Pig iron (blast furnace)	220,000	248,000	261,000	277,000	227,000	325,000	339,000
Steel ingots (open hearth)	178,000	246,000	313,000	321,000	298,000	381,000	388,000
Merchant mill products	75,000	103,000	102,000	125,000	118,000	137 000	122,000
Plates	19,000	29,000	37,000	36,000	32,000	50,000	51,000
Sheets	20,000	34,000	46,000	42,000	50,000	61,000	62,000
Tinplate	12,000	16,000	13,000	18,000	18,000	20,000	16,000

increases respectively. The variations or departures of production from capacity are due to strike and blast furnace relining periods.

MODERNIZATION PROGRAM—1955

A modernization program was started in 1955 to replace the old hand mill by a semi-continuous hot strip mill and auxiliary facilities. Modification of the existing 32-in. blooming mill to a high-lift mill made edging work possible.

One $\frac{3}{4}$ x 22 x 100 in., 3-high combination plate and roughing mill with 20 in. vertical edger.
One $24\frac{3}{4}$ in. and 46-in. x 48-in. 4-high reversing hot strip mill.
One coil shearing line to produce coil breakdowns for use in existing hand finishing mills until cold mill facilities are in operation.
One coil slitting and side trimming line.

The installation of the semi-continuous hot strip mill involved a total expenditure equivalent to $12,050,000 (U. S.), of which $7,199,310 (U. S.) represents expenditures in the United States and $4,850,680 (U. S.) represents expenditures in Chile.

Besides, a comprehensive survey of all CAP operations was prepared in 1956 to establish the future plans of the company. The survey forecasts a domestic market demand of around 360,000 metric tons of salable products by 1960. Of this total, 160,000 metric tons are merchant products, 180,000 metric tons are flat rolled products, and the balance are semifinished products. This market requires production of more than 430,000 metric tons of steel ingots.

DEVELOPMENT PROGRAM—1958

Financing—This survey recommended a development program that embodies the immediate installation of a 200-ton open hearth furnace and a 3-stand tandem cold strip mill together with required auxiliary equipment. The estimated capital cost of these new facilities is $28,002,000 (U. S.), of which $16,927,000 (U. S.) represents expenditures in the United States and $11,075,000 (U. S.) represents expenditures in Chilean currency.

For these projects the Export-Import-Bank has loaned to CAP $3,550,000 (U. S.) for the open hearth and $16,000,000 (U. S.) for the cold strip mill.

Following is the breakdown of the financing of these programs:

		U. S. dollars			*Pesos expressed in equivalent U. S. dollars*
Program	*Grand total*	*Total*	*Export-import Bank*	*CAP*	*CAP*
Hot strip mill	$12,289,000	$ 7,887,000	$ 3,550,000	$4,337,000	$ 4,402,000
Development program	28,002,000	16,927,000	16,000,000	927,000	11,075,000
Total	$40,291,000	$24,814,000	$19,550,000	$5,264,000	$15,477,000

It can readily be seen that of a total expenditure of $40,291,000 (U. S.) for the two programs the Export-Import Bank is assisting with $19,550,000 (U. S.); and CAP, from its own resources and manufacturers' credits, is completing the financing of both projects to the amount of $20,741,000 (U. S.) of which $5,264,000 (U. S.) represents expenditures in the United States and $15,477,000 (U. S.) represents expenditures in Chile. The obligations represented by these figures, in themselves, indicates the tremendous effort of our company to improve its operations.

The essential facilities incorporated in the development program are as follows:

One 200-metric ton open hearth furnace and waste heat boiler plus a 10-ton charging machine, and a dolomite machine.
Additional raw material storage beds and conveyors.
Soaking pit cover crane.
Slab reheating furnace—capacity 50 metric tons per hr from cold material.
Scarfing facilities.
Plate finishing facilities.
Pickling line—170 fpm with provisions to increase to 240 fpm with overvoltage.
21-in. and 53 x 48-in. 3-stand tandem mill, maximum initial speed 1440 fpm with provisions for a fourth stand, maximum speed of 2340 fpm.
19-in. and 43 x 48-in. 4-high temper mill, maximum 2000 fpm.
42-in. alkali cleaning line—750 fpm.
Tinplate and sheet shear lines.
Six stack type annealing furnaces and 18 bases.

The installation of these facilities is expected to lower direct production costs by an average of $12 (U. S.) per metric ton of product. This saving when combined with an increase of more than 50,000 tons of salable product, due mainly to better yields and improved processes, will produce a substantial additional profit at plant level before overhead and depreciation.

The other essential objective of this program, however, is to permit CAP to lower its prices and thereby stimulate the further industrial development of Chile.

In its first ten years of operation the company will have invested $76,200,000 in improvements that added to the original investment will result in a total of $153,000,000 at the end of 1959. These investments were and will mainly be responsible for the increase in

TABLE II
Capacity Growth
(Metric Tons)

Years		Steel ingots	Finished products
1950	Original project	236,000	158,300
1951	Improvement program	279,500	201,650
1952	Capacities improved by changes of processes and general improvement of productivity	360,000	265,500
1958	Hot strip mill and development program	430,000	330,000

production, mechanization of the plant, and improvement in product quality.

OPERATION OF THE PLANT

The blast furnace of Huachipato was relined from the mantle up in 1955, and its working volume was increased from 23,870 to 24,914 cu ft. This was accomplished by suppressing the 4½-in. air space between the furnace shell and the adjacent refractories. This relining job took 23 days. This furnace has a 20 ft-9 in. hearth diam and has increased its average production per day from 678 metric tons in 1952 to over 950 metric tons in the early part of the fiscal year 1957–58. In turn, the coke rate has decreased steadily from 906 kg per metric ton of iron in 1952 to 739 in 1957. These improvements were obtained through the use of improved ore preparation, the addition of sintering facilities, the increase of hot blast temperature through installation of a fourth stove, and an ever improving practice.

The steel shop ingot production reached a total of 388,000 metric tons in the year 1957 due largely to an increase of available hot iron from the blast furnace, as explained. This production is obtained from three 100-metric ton basic stationary open hearth furnaces employing the duplex process and two 15-metric ton acid bessemer converters. Other factors contributing to this increased ingot tonnage were: (a) improved bessemer operation, by increasing size of blow, charging techniques and skill of blowers, (b) improved maintenance, faster furnace rebuilds through proper incentive programs and improved techniques, slight revisions of furnace design, (c) increased heat weights and (d) improved skill of operators that brought about a reduction of time for bottom repair, increased furnace availability, and better pouring practices that resulted in over-all improvement of quality.

Throughout the rest of the mill a concerted effort of the industrial engineering staff, safety and training personnel and an ever increasing decentralization of management functions resulted in a very appropriate climate of co-operation throughout the organization. This, in turn, has meant a responsible attitude of employees in their jobs and is reflected in higher yields and maintenance of reasonable costs.

SALES AND MARKETS

From the figures of Table III it can be seen that the consumption of steel in Chile has constantly increased, confirming a generally accepted statement that the very availability of steel in a country with such an incipient industry is an important actor in fostering its consumption.

TABLE III
Sales—Total Chilean Steel Consumption From 1951 to 1958
(Metric Tons)

Year	Total
1951	122,537
1952	166,672
1953	209,854
1954	218,557
1955	218,906
Jan./June 1956	117,204
July 1956/June 1957	275,710
July 1957/June 1958	266,546

It has been the policy of CAP to sell its products in Chile at prices below the cost of importing them. In this cost, the cost-insurance-freight value Chilean port plus the custom duties are considered. At present the weighted average of CAP prices for all products is 22 per cent lower than the average price of the imported products.

Table IV shows a comparison of prices as of September, 1958.

ECONOMIC EFFECTS OF THE STEEL PLANT

At the current rate of production and prevailing prices the gross income from sales amounts to approximately $55,000,000 per year. All profits of CAP have been reinvested to increase production and yields, improve quality, and decrease costs over the years.

The net yearly saving in foreign currency derived from the operation of the Huachipato plant has increased from $5,200,000 in 1952 to $25,000,000 in 1957 for a total of more than $100,000,000 between 1951 and June, 1958. These results were obtained by adding the income from export sales to the import dollar value, custom duties excluded, of the products sold in the local market and deducting the dollars required to service the U.S.A. credits, the cost of North American technical services, and imported operating supplies. Moreover, indirectly these figures are increased by the savings on imports of metallurgical industry products that are now produced in Chile and the income resulting from the exports of such products.

The continuous and assured supply of steel to the existing metallurgical industry has resulted in its uninterrupted growth. Also, it has created the basis for new

TABLE IV
Comparison Between Cost of Imported Steel Products With CAP'S Prices
Date: September, 1958
US Dollars per Metric Ton

Product	CAP'S prices FOB Huachipato	Imported prices CIF Chilean port
Round bars	187	263
Wire rod	194	274
Flat bars	211	274
Shapes	223	275
Skelps	200	...
Plates	204	256
Tinplate (base box)	32	35
Pickled sheets	242	275
Hot rolled sheets	227	264
Galvanized sheets	315	383

metallurgical concerns in the neighborhood of the steel plant, such as a wire drawing plant with 35,000 metric ton product capacity. Structural, fabricating, pipe, and a grinding ball manufacturing plant have also been started.

The wealth saved by making available in Chile commodities which would otherwise have to be imported can be used to import equipment, machinery, raw materials and supplies not available in the country for other industries.

The salaries of employees and the purchase of services and supplies in Chile also add a sizeable amount to the gross national income thus increasing the standard of living.

A major consideration is that not only has the economic effect of the installation of the steel plant favorably affected Chileans directly, but it has also contributed to a greatly increased Chilean commerce with the United States.

As previously stated the Export-Import Bank has granted $80,300,000 credit for the installation and expansion of the steel mill between 1947 and 1958. In addition, U. S. suppliers have given credit to CAP for its original installations to the amount of $3,000,000. This whole amount was spent or is in the process of being spent in the U. S. A. for capital equipment and technical services. During the same period CAP has spent in this country from its own resources an additional sum of $75,000,000 for capital equipment, operating supplies and technical services. In other words, while Export-Import Bank has loaned CAP $80,300,000, CAP has repaid half of this debt and spent an additional $75,000,000, Table No. V, for supplies and services.

In conclusion, the businesslike economic assistance obtained by our company from the United States through the Export-Import Bank of Washington has strengthened the Chilean economy in a solid and substantial way, has improved trade with the United States and has in this way contributed to the real and warm friendship between our countries.

TABLE V
CAP Remittances to USA 1947 to 1958
(US Dollars)

Year	Payment of debt	Purchase of technical services in USA	Supplies and materials purchased in USA
1947	$ 30,253	$	$
1948	268,856		
1949	1,025,826	1,500,000	
1950	2,300,932	1,500,000	1,025,000
1951	4,133,672	1,500,000	7,231,170
1952	4,205,929	1,320,740	11,827,100
1953	4,342,822	1,250,000	7,583,047
1954	4,381,772	1,870,000	7,586,323
1955	4,773,046	1,544,684	6,476,420
1956	4,826,150	2,220,000	6,586,750
1957	4,865,000	1,200,000	6,125,251
1958 (estimated)	5,000,000	1,200,000	6,200,000
Totals	$40,154,262	$15,105,424	$60,461,061

Grand total: $115,900,740

Discussion

PRESENTED BY

FREEMAN H. DYKE, Vice President and General Manager
United States Metals Refining Co.,
Sub-American Metals Co., Cartaret, N. J.

R. TIETIG, JR., Principal Engineer,
Steel Plants Development, Kaiser Engineers,
Div. of Henry J. Kaiser Co., Oakland, Calif.

D. MAXWELL SEELEY,
Assistant to Vice President—Appropriations,
United States Steel Corp., Pittsburgh, Pa.

E. S. HARMON, President,
E. S. Harmon Corp., Chicago, Ill.

FRED E. KLING, Steel Works Engineer, Tenafly, N. J.

Freeman H. Dyke: There were many problems which had to be solved. The site of the plant had sand dunes with heavy growths of coniferous trees. These had to be cut; a saw mill was set up and the resulting lumber used for form work. A tremendous yardage of sand had to be leveled off before construction could be started. Since Concepcion is an earthquake belt, all foundations and buildings had to be designed to withstand this potential hazard. Experience has shown that a remarkable job was accomplished as there have been heavy shocks since the plant was put in operation with no damage.

I cannot compliment too highly the ability of the Chilean labor to learn and to adapt themselves to new conditions. Their performance, for a minimum of training, was remarkable. In addition, the Chilean engineers are exceptionally well trained. They work long hours, and most important, they will work with their hands in order to get the feel of the job. They have become good steel men.

All in all, Chile has done a remarkable job with a minimum of outside help.

R. Tietig, Jr.: The history of the growth of Compania de Acero del Pacifico provides an excellent guide as to the manner in which a country should develop a steel industry. Outstanding is the fact that no attempt was made to incorporate in the original construction many facilities that were well established elsewhere but which would have proved economically unsound in Chile. For example, the blast furnace was 660 net tons capacity, when 1300-ton units were being built here. Furthermore, the open hearths tapped only 75-ton heats when those of 235 tons upwards were current elsewhere. Also, sheets were made on equipment of the type last installed in the United States in the late 1920's.

This restraint and actual courage in selection and design of equipment probably was a principal contributing factor as to why the operation has been the success indicated by the figures given by the author. Here was a plant built with a minimum of expense where men could learn. Here was a plant that could easily operate at capacity and, hence, at a considerable profit because it could not fill the demand. Here the planning was truly for the future to suit the existing abilities and needs of a country that eventually wanted to control its source of steel.

There must have been a great temptation to build a far different plant—a plant that could have produced three times as much iron and steel from a variety of high production units. None of these units would have been profitable because each would have operated at only a fraction of capacity.

D. Maxwell Seeley: This paper is an example of sound economic planning and construction of a steel plant in an area with ore and coal plus an abundance of hydroelectric power and adequate labor forces. The site selection adjacent to a deep sea water harbor alleviated the export and import transportation problems.

This small but fully integrated plant is an excellent example of versatility in a market of limited total tonnage as compared to larger and more specialized plants elsewhere in the world.

As in the steel industries of Japan and Venezuela, Compania de Acero del Pacifico's expansion and growth of its production in Chile reflect steel's increasing use and acceptance everywhere.

E. S. Harmon: Prior to 1943 Chile had prepared analyses on two steel plant projects. The first was based on the Brassert-Cape process and the second on electric smelting processes.

After reviewing the project it was apparent that a small electric smelter plant of the capacity contemplated could not be financed, and the operation of the plant would be marginal. In contrast to this, studies on a 500-ton blast furnace indicated that a completely integrated steel plant of that capacity could be financed and be a highly profitable venture.

There are two yardsticks by which the merits of creating a steel plant may be measured: (1) will it be good for the economy of the country, (2) will the return be high enough to pay the indebtedness and a good return to the investors. The final Chilean project satisfies both these requirements.

Chile with 2800 miles of coast line was anxious to decentralize the population, which was centered about Santiago and Valparaiso. Northern Chile where large mineral deposits are located is mostly desert area. Southern Chile is a large timber area and mostly undeveloped while the extreme southern area has oil and gas fields and large deposits of lignite. The central area is the most highly developed section of Chile, the southern part of this central section containing large deposits of coal. The coal mines in this area extend for more than five miles under the ocean at the Gulf of Arauco, 300 miles south of Santiago and 30 miles south of Concepcion. The iron mines are some 200 miles north of Santiago. From the standpoint of site and harbor facilities, the Port of Quintay, just south of Valparaiso, offered the best location, but it did not satisfy Chile's plans for decentralizing the population. The San Vicente Bay near Concepcion, where the plant now stands, was selected on the basis that it met with the decentralization program and was within 30 miles of the coal mines. Inasmuch as the Concepcion area is in an earthquake zone, earthquake-proof construction was required. All this work was done under the direction of Chilean earthquake engineers who did an exceptionally good job.

Through a re-examination of custom records, including products which could be made in Chile if materials were available, it was established that market requirements exceeded the amount of products from a 500-ton blast furnace. Consumption records of other countries established that the consumption of steel doubled within three years after domestic steel was available.

While a low grade metallurgical coke could be made from Chilean coal, mixing with U. S. coal was required to obtain the best results from a blast furnace. Chile had little scrap available in the country. While some grades of steel could be made in a bessemer furnace, many grades required open hearth steel. In the absence of scrap and the necessity for open hearth steel the plant was provided with both bessemer and open hearth furnaces to provide the bessemer grades and duplexing for the open hearth.

An electric weld pipe mill, 5 to 12-in. range, was purchased to produce pipe because pipe could not be purchased at that time.

As a matter of policy Chile desired to promote private enterprise in their planning. For that reason, the steel plant products were confined as much as was practical to commodities usable as raw materials by industrial plants. For instance, wire rod rather than finished wire and wire products were scheduled.

From the analyses developed, certain basic facts stood out as norms which could be used as guides for establishing a steel plant in a nonindustrialized country.

1. Where a country must pay high freight charges and import duty for steel imports, the amount thus paid should revert to the profit margin of a steel plant if one is established.

2. Production costs must be competitive, otherwise the profit margin made possible by higher prices will not be available for amortization purposes.

3. Establishing a competitive steel plant in a nonindustrialized country requires new transportation facilities and new freight rates based on volume. The use of existing freight rates will usually result in the plant being noncompetitive.

4. A 500-ton blast furnace, with a coke plant, was the smallest integrated steel plant that could be justified at that time. With the new direct reduction processes and oxygen converter processes now available plant sizes can be materially less.

5. In ascertaining market requirements, manufactured iron and steel products, which could be produced, should be included as one of the objectives to permit industrialization.

6. Most countries can justify a steel plant if they approach the subject as did the Chileans. If the initial market will not justify an integrated plant, a nonintegrated plant can be built, and ore reduction units installed later with considerable foreign exchange savings.

Fred E. Kling: Mr. Dyke mentioned that the plant is located in a part of Chile subject to severe earthquakes. Chilean experts checked the design of all structures for ability to withstand seismic forces. The blast furnace was the most intricate problem as a conventional construction of support proved to be unsatisfactory. The latter was then made of a design with base plate, columns and mantle of box section, with large radius fillets provided at their junctions, and welded together to a monolithic structure, described in an article, "Blast Furnace Design Problems," *Blast Furnace and Steel Plant*, July 1954.

This furnace withstood several earthquakes, one of which was so severe that the top swayed 4 ft. Nothing failed except the connection of the walkway from the stoves to the top of the furnace. The construction is not only much stronger than the conventional design but, to the surprise of everybody, less expensive saving about $42,000. ▲

PROGRAM

AISE SPRING CONFERENCE

Auspices of Rolling Mill Committee

THE STATLER HILTON HOTEL
BUFFALO, N. Y.

April 27, 28, 29, 1959

MONDAY, APRIL 27, 1959

8:30 am—REGISTRATION—
Mezzanine Floor, The Statler Hilton Hotel

9:00 am—ROLLING MILL SESSION—
Show Room

Chairmen: R. C. Schaefer, Assistant Superintendent, Hot Strip, Soaking Pit, and Blooming Mill Dept., Wheeling Steel Corp., Steubenville, Ohio

M. J. Cooper, Superintendent of Hot Mills, Dominion Foundries & Steel Limited, Hamilton, Ontario, Canada

"The Swedish Type of Repeater Mills for High Quality Steels" by Erik Norlindh, Morgardshammars Mek. Verkstads AB, Morgardshammar, Sweden

"Applications of Roll Ragging" by Herman E. Muller, Superintendent Roll Dept., Indiana Harbor Works, Inland Steel Co., East Chicago, Ind.

"Kaiser's New Hot Strip Mill" by Lawrence L. Freret, Chief Project Engineer, Kaiser Engineers, Div. of Henry J. Kaiser Co., Oakland, Calif.

9:00 am—MECHANICAL SESSION—
New York Room

Chairmen: Charles H. Good, Jr., Chief Engineer—Central Operations, Fairless Works, United States Steel Corp., Fairless Hills, Pa.

J. O. Dague, Superintendent, Mechanical Dept., Bethlehem Steel Co., Lackawanna, N. Y.

"A New Application for Salt Bath Treatment of Eutectoid Steel" by E. W. Stotz, Assistant Chief Metallurgist, Bethlehem Steel Co., Johnstown, Pa.

"The Use of Oil-Film Bearings on a 12-In. Merchant Mill" by H. Stanley Baldwin, General Foreman, 12-In. Merchant Mill, Sheffield Div., Armco Steel Corp., Kansas City, Mo.

"Some Uses for Ultrasonics in Industry" by A. Dixon, Supervisory Engineer, Metals Joining Section, Headquarters Manufacturing Laboratory, Westinghouse Electric Corp., East Pittsburgh, Pa.

2:00 pm—ROLLING MILL SESSION—
Show Room

Chairmen: D. W. McLean, Superintendent Rod & Bar Mills, Steel Company of Canada, Limited, Hamilton, Ontario, Canada.

Fred T. Van Camp, Works Manager, Buffalo Steel Corp, Tonawanda, N. Y.

"High Speed–Rod Rolling" by Earle L. Chamberlain, Division Superintendent, Hot Mills, Cuyahoga Works, American Steel & Wire Div., United States Steel Corp., Cleveland, Ohio.

"Fundidora de Fierro y Acero de Monterrey-Mexico—Reports on Their New Combination Merchant Bar and Rod Mill" by B. R. Wible, Engineering Consultant to Management, and A. Fernandez, General Superintendent of Rolling Mills, Cia. Fundidora de Fierro y Acero de Monterrey, S.A., Monterrey, N. L., Mexico.

"Application and Selection of Gear Type Spindles," by Fred H. Paddon, Manager of Engineering & Sales, Amerigear/Bliss Spindles, Rolling Mill Div., E. W. Bliss Co., Salem, Ohio

2:00 pm—ELECTRICAL SESSION—
New York Room

Chairmen: R. G. Nolan, Electrical Engineer, Granite City Steel Co., Granite City, Ill.

Clayton L. Squier, Assistant Electrical Superintendent, Bethlehem Steel Co., Lackawanna, N. Y.

"54 Years of Operation of the First Electric Driven Reversing Mill," by George H. Krapf, Division Superintendent, Power Production, and Elmer I. Pearson, Assistant Chief Engineer, South Works, United States Steel Corp., Chicago, Ill.

Spring Conference Chairmen

R. C. SCHAEFER | M. J. COOPER | C. H. GOOD, JR. | J. O. DAGUE | D. W. McLEAN | F. T. VAN CAMP | R. G. NOLAN

"Automatic Gage Control on Cold Rolling Mills at Dofasco" by N. D. Stephens, Electrical Superintendent, Dominion Foundries and Steel, Limited, Hamilton, Ontario, Canada

"Application of Individual Drive Motors to Mill Table Rolls" by Anthony Jakimovich, Application Engineer, Metal Rolling & Process Engineering, Industrial Engineering Section, General Electric Co., Schenectady, N. Y.

TUESDAY, APRIL 28, 1959

9:00 am—ROLLING MILL SESSION— Show Room

Chairmen: F. G. Kredel, Chairman, Bar Mill Committee, Republic Steel Corp., Cleveland, Ohio

George A. Henderson, Superintendent, Rolling Mill Div., Bethlehem Steel Co., Lackawanna, N. Y.

"Fire Cracking in Rolling Mill Rolls," by N. R. Arant, Technical Director, Roll Manufacturers Institute, Pittsburgh, Pa.

"Mathematical Aids to Determine Bar Spread and Reduction Rates in Rolling" by Louis Moses, Mill Engineer, Bethlehem Steel Co., Bethlehem, Pa.

"Republic's Bar Mill of Tomorrow" by D. E. Weaver, Superintendent, Finishing Mills, and H. E. Berg, Chief Engineer, Chicago District, Republic Steel Corp., Chicago, Ill.

9:00 am—COMBUSTION SESSION— New York Room

Chairmen: David Cousley, Assistant Superintendent, Utilities, Wheeling Steel Corp., Steubenville, Ohio.

E. T. W. Bailey, Chief Fuel Research Engineer, The Steel Co. of Canada, Limited, Hamilton, Ontario, Canada.

"Safe Control of a Mixed Gas Distribution System Without the Use of a Holder" by Burton D. Barns, Supervisor, Fuel and Utility Section, Plant and Production Engineering Dept., Steel Div., Ford Motor Co., Dearborn, Mich.

"High Head Alloy Slab Heating for Planetary Mill Rolling" by Oscar J. Zanatta, Utilities Engineer, Atlas Steels Limited, Welland, Ontario, Canada.

"Continuous Annealing in Molten Sodium" by J. D. Keller, Partner, Associated Engineers, Pittsburgh, Pa.

2:00 pm—OFF-THE-RECORD ROLLING MILL PANEL DISCUSSIONS—

SHAPED PRODUCTS SESSION Show Room

Moderator: Don C. Horsman, Plant Superintendent, Continental Steel Corp., Kokomo, Ind.

Crush grinding—A potential aid to quality and service on finishing mill rolls

Effective guide programs—Design, materials, performance and maintenance

The role of large coils—In present and future production and markets

Panel: Earle L. Chamberlain, Division Superintendent, Hot Mills, Cuyahoga Works, American Steel and Wire Div., United States Steel Corp., Cleveland, Ohio

Ted S. Dull, Jr., Superintendent, Roll Service, Sheffield Steel Div., Armco Steel Corp., Kansas City, Mo.

W. Fulginiti, General Foreman, No. 1 Rod Mill, Cuyahoga Works American Steel & Wire Div., United States Steel Corp., Cleveland, Ohio

Lawrence M. McDowell, Superintendent, Gautier Dept., Bethlehem Steel Co., Johnstown, Pa.

Marshall T. Magee, Jr., Division Superintendent Rod Mills, American Steel & Wire Div., United States Steel Corp., Donora, Pa.

D. W. McLean, Superintendent Rod & Bar Mills, Steel Company of Canada, Limited, Hamilton, Ontario, Canada

Milton J. Oehler, Superintendent Bar Mills, Republic Steel Corp., Buffalo, N. Y.

Robert L. Sheets, Field Engineer, The Sheffield Corp., Dayton, Ohio

Howard Tomasch, General Foreman, Hot Mill Roll Shop, Cuyahoga Works, American Steel & Wire Div., United States Steel Corp., Cleveland, Ohio

Fred T. Van Camp, General Night Superintendent, Wickwire Spencer Steel Div., The Colorado Fuel and Iron Corp., Buffalo, N. Y.

D. E. Weaver, Superintendent Finishing Mills, Chicago District, Republic Steel Corp., Chicago, Ill.

Frank F. Zipf, Superintendent Roll Dept., Gautier Works, Bethlehem Steel Co., Johnstown, Pa.

FLAT PRODUCTS SESSION New York Room

Moderator: R. P. Schuler, Manager of North Mills, Indiana Harbor Works, Inland Steel Co., East Chicago, Ind.

The incidence of ridges (buildup) on cold-rolled products and their relation to the hot mill band.

The control of rundown on the hot mill band and its effect in subsequent operations.

Hot mill roll banding, and its effect on cold-rolled products.

Hot mill roll profile and its relation to the profile of the hot mill band.

Control of hot mill roll profile and the effect of roll coolant.

Any related problems in the production of hot mill bands.

Panel: J. F. Griffin, Process Metallurgist, United States Steel Corp., Pittsburgh, Pa.

Louis Such, General Superintendent, Hot Rolling & Conditioning, Allegheny Ludlum Steel Corp., Brackenridge, Pa.

James N. Imel, Superintendent, Sheet & Tin Strip Depts., Pittsburgh Works, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

W. H. Rees, Assistant Manager, Wide Strip Div., Great Lakes Steel Corp., Ecorse, Detroit, Mich.

J. S. Ride, Development Div., Metallurgical Dept., Steel Company of Canada, Limited, Hamilton, Ontario, Canada

7:00 pm—INFORMAL STAG DINNER— Ballroom

Speaker: H. G. DeYoung, President, Atlas Steels Limited, Welland, Ontario, Canada

WEDNESDAY, APRIL 29, 1959

8:30 am—INSPECTION TRIP—

Atlas Steels Limited, Welland, Ontario, Canada, and the direct reduction plant of **Strategic-Udy Metallurgical & Chemical Processes, Ltd.,** Niagara Falls, Ontario, Canada. Buses will leave from the Statler Hilton Hotel and will be back before 5:00 pm.

Spring Conference Chairmen

C. L. SQUIER

F. G. KREDEL

G. A. HENDERSON

DAVID COUSLEY

E. T. W. BAILEY

DON C. HORSMAN

R. P. SCHULER

Abstracts of Technical Papers

to be presented at technical sessions of

AISE SPRING CONFERENCE

April 27, 28, 29, 1959

The Statler Hilton Hotel **Buffalo, N.Y.**

"THE SWEDISH TYPE OF REPEATER MILLS FOR HIGH QUALITY STEELS"

by ERIK NORLINDH, Morgardshammars Mek. Verkstads AB, Morgardshammar, Sweden

ERIK NORLINDH

△ OVER the past twenty years much development work has been carried out in Sweden regarding the economical and functional design of repeater rolling in 3-high and alternating 2-high mills.

A fundamentally different method has been achieved in that the oval twists of its own accord to the vertical position since it is bent downwards and sideways in a suitable fashion as it passes the repeater. The absence of twist guides gives a much greater reliability permitting also the rolling of different steel qualities and oval sizes without the necessity of any intermediate adjustments.

In the case of leader ovals and small breakdown ovals, specially designed roller guides have been applied which spring apart slightly as the oval enters. Furthermore, whip channels have been introduced to eliminate double-folded tail ends, which would otherwise occur when the tail end is whipped at high speed.

As universal couplings are required when repeating ovals, much attention has been given to the question of lubrication, and suitable grease bath couplings are now available even for the highest operation speeds.

In connection with the large inclination associated with leader oval repeaters, a new type of alternating 2-high mill stand has been perfected, and a similar design is now applied to the 3-high. A vertical roll unit can also be fitted to deal with flats.

New equipment to direct the bars onto the cooling bed at high speeds has been developed and facilities for sampling after the finishing stand have been tried out.

The paper contains information on some actual layouts for bar and wire rod rolling in high-grade steel works, and the operating experience of such a plant is related.

"APPLICATIONS OF ROLL RAGGING"

by HERMAN E. MULLER, Superintendent, Roll Department, Indiana Harbor Works, Inland Steel Co., East Chicago, Ind.

H. E. MULLER

△ AT the outset it is perhaps well to state that this paper is not the result of original research or specific operations studies and tests, nor is it a purely academic approach. It is of a survey nature with the object of reporting present day practices with respect to primary, secondary and finishing mills.

This subject cannot be approached without discussing rolling theory. Much of this has been developed in the past by other authors. However, in discussing possible effects of ragging it is important to keep the theory in mind in order to predict and evaluate results.

Today, as never before, rolling mills are under intense pressure to obtain productivity increases. Ragging and knurling, more often than not, has been used to gain this advantage. There are many controversies

raging as to the good and detrimental effects of either knurling or ragging. There is a great deal of prejudice and opinion. These lead to erroneous conclusions, and very often defeat attempts at solving problems relative to quality and production.

Designing ragging into the roll reduction systems of mills demands a careful scientific testing program. Otherwise surface defects resulting from ragging may be overlooked, and defects originated from other causes may be blamed on knurling or ragging resulting in a penalty in quality or production rate. A study of the finished product requirement from a surface standpoint should be the beginning of any program. It is well known that finished product requirements in the trade relative to surface are widely variable. Yet in most cases primary rolling must be done in the same mill and sometimes in the same secondary mill. Such a situation requires a compromised solution.

A quick reference chart illustrating contemporary ragging patterns is included as part of this work. Its purpose is to provide an evaluation key so that designers will be guided somewhat as to method of approach. It is not to be construed as a foolproof system of recommendation. Because of widely varying heating, rolling and conditioning practices, such problems must be handled in a unique manner in almost every case.

References to other works relating to this and a bibliography is appended.

"KAISER'S NEW HOT STRIP MILL"

by LAWRENCE L. FRERET, Chief Project Engineer, Kaiser Engineers, Div. of Henry J. Kaiser Co., Oakland, Calif.

L. L. FRERET

△ THIS new 86-in. hot strip mill was designed to handle slabs from 4000 to 30,000 lb, 4 to 7 in. thick, up to 80 in. wide, with a maximum length of approximately 260 in. The finished product may vary in gage from a 0.375 in. for light plate to 0.048 in. for strip.

Three slab heating recuperative type furnaces, 20 ft inside width and 100 ft from the charging door to the discharge knuckle, with a capacity to heat 136 tons per hr of cold charged slabs, are installed. Each furnace has needle type recuperators, three zones of burners, one set of screening burners, stack and flue.

The charging and discharging equipment consists of one furnace charging table which is 120 ft in length, one slab depiler magazine and pusher and three furnace pushers.

The new roughing mill consists of a new roughing train which consists of a furnace delivery table which is 208 ft in length with adjustable side-guards entering the horizontal scalebreaker. The 36 x 86-in. 2-high scalebreaker is equipped with oil film bearings, pinion stand and gear drive and is driven by a 1000-hp motor, 400-rpm pedestal type wound-rotor a-c motor and flywheel.

A turn-around table is provided between the scalebreaker and the broadside mill. This table has tapered rollers with drives on each side of the table. This table is duplicated on the delivery side of the broadside mill.

The 42 & 54 x 132-in. 4-high reversing broadside mill has oil-film bearings on the backup rolls and roller bearings on the work rolls, pinion stand and gear drive. This mill is driven by a 3500-hp motor, 514-rpm pedestal type, wound-rotor a-c motor with flywheel.

A slab pusher has been provided on the entering side of the broadside mill. A slab squeezer, driven through a 500-hp motor, has been provided. The broadside mill is followed by four roughing stands:

No. 1 is 38 & 54 x 86-in. 4-high with 6000-hp, 514-rpm, a-c synchronous motor
No. 2 is 38 & 54 x 86-in. 4-high with 6000-hp, 514-rpm, a-c synchronous motor
No. 3 is 34 & 54 x 86-in. 4-high with 6000-hp, 514-rpm, a-c synchronous motor
No. 4 is 34 & 54 x 86-in. 4-high with 6000-hp, 514-rpm, a-c synchronous motor

All four stands have oil-film bearings on the backup rolls and roller bearings on the work rolls complete with pinion stands and gear drives.

Vertical edgers have also been provided on the entry side of each roughing stand. The mill tables between the mills down to No. 4 rougher are gear-driven tables and beyond that are individually motor-driven rolls.

The mill distribution system is 6.9-kv with two new switchgear lineups; some of the existing 6.9-kv switchgear has been relocated to the new motor room.

Two coilers will be relocated from the existing finishing train to coil production in varying gages and widths for delivery to the various skelp mills and to the tin mill.

The present 6-stand, 86-in., wide finishing train has been relocated to the new roughing train. The problems of relocation have been carefully studied, and the move of this machinery with all of its electrics has been proceeding as planned.

This 12-stand mill is located in a building 2900 ft long x 100 ft wide. The entire building has 700,000 sq ft of floor space.

"A NEW APPLICATION FOR SALT BATH TREATMENT OF EUTECTOID STEEL"

by E. W. STOTZ, Assistant Chief Metallurgist, Bethlehem Steel Co., Johnstown, Pa.

E. W. STOTZ

△ THE steel to be heat treated by this process is rolled into a modified T-section approximately 2 in. high. It is then cut to length, heated and formed into the finished part on a press. The end use of the product is essentially a spring. Before the installation of the salt bath the parts were heat treated by oil quenching directly from the press and then tempering in a furnace back to the desired hardness level.

The new process involved replacement of the oil quench and tempering facilities with a salt bath furnace and a water rinse tank. The system is automatic with the parts conveyed through the salt bath and water rinse by conveyor belts. The steel goes directly into the salt bath from the forming press with the liquid salt maintained at a temperature of 675 F. The result-

ant structure is a mixture of fine pearlite instead of the tempered martensite previously obtained. This treatment meets the desired hardness range of the finished product, and the uniformity of the hardness results and the ductility of the spring are superior to the oil-quenched and tempered product.

"THE USE OF OIL-FILM BEARINGS ON A 12-IN. MERCHANT MILL"

by H. STANLEY BALDWIN, General Foreman, 12-In. Merchant Mill, Sheffied Div., Armco Steel Corp., Kansas City, Mo.

H. S. BALDWIN

△ THE 12-in. mill is a 15-stand merchant mill consisting of twelve horizontal and three vertical roll housings. All horizontal stands are equipped with oil-film bearings. The three in-line finishing stands are used for rolling rounds $\frac{7}{16}$ through $\frac{47}{64}$-in. All other products are rolled out of a single finishing stand.

Range of products include $\frac{7}{16}$ through 2-in. rounds; 3 in. x 4.1-lb, 4 in. x 5.4-lb channel; $1\frac{1}{2} \times \frac{3}{16}$ through $6 \times \frac{3}{4}$-in. flats; $1\frac{1}{2} \times 1\frac{1}{2} \times \frac{3}{16}$ through $4 \times 4 \times \frac{1}{2}$-in. angles and $1\frac{1}{4}$, $1\frac{1}{2}$ and $1\frac{3}{4}$-in. round cornered squares are rolled on this mill.

One hundred and twelve bearings make up our bearing inventory. Twenty-eight are of the 16-in. size while the remaining 84 bearings are 12 in.

Main oil headers and return lines bring the oil to the roll stand and return the oil to the oil reservoir. Flexible hoses connect the headers to the movable roll stands. A system of warning lights is used to indicate a loss of supply oil. The lights are operated by pressure switches.

Two men operate the bearing shop and work the daylight turn only. These men maintain all bearings and remove and install all roll bearings. The secret of success in using oil-film bearings can be expressed in one word, cleanliness. Clean bearings will run over prolonged periods of time with a minimum of maintenance. Most nonmoving parts are painted which facilitates cleaning. Some bearings have been used on the slow-speed stands without dismantling for 18 months. The higher speed stand bearings are reconditioned on an average of once every three months.

As in the case of cleanliness of the bearings so it is with the lubricating oil. This oil is circulated from two systems serving two sections of the mill. Each system has two tanks, and only one of them is used at a time. The oil in each idle tank is cleaned while the other tank is supplying the mill. Water is removed by precipitation as well as being passed through a centrifuge. Solid particles are removed from the oil by use of disk type strainers in the active systems.

As with any operation problems do arise. Bearing failures have been caused by plugged orifices at the bearings and stray bits of metal contaminants in the oil. These problems were resolved by locating the source and protecting against it. Oil flow in cold weather has presented problems but can be remedied by raising the temperature of the oil at the reservoir tank or tracing return lines with steam.

The ability to hold the roll in the desired position for a long period of time is its primary virtue. Small rounds are rolled within commercial tolerances, and the only adjustment needed is for pass wear compensation. Angles are rolled on open passes on this mill. Even unequal leg angles can be held to a minimum of variation. The uniform leg thickness on angles allow accurate straightening with a minimum of effort.

The success of using oil-film bearings can be largely attributed to the personnel in the bearing shop. The bearings look as good, if not better, after 10 years use than they did the day they were uncrated. As is seen from the range of sizes rolled on this mill, the bearings are given a good workout. The confidence in this type bearing is best expressed by our company having ordered a 23-stand rod and merchant mill equipped with oil-film bearings throughout.

"SOME USES FOR ULTRASONICS IN INDUSTRY"

by A. DIXON, Supervisory Engineer, Metals Joining Section, Headquarters Manufacturing Laboratory, Westinghouse Electric Corp., East Pittsburgh, Pa.

A. DIXON

△ THE economics and scope of problems encountered in material processing continually influences research for new and better methods. As a result of this effort the ultrasonic process is emerging from the laboratory stage and gaining increased acceptance for industrial use. Many applications enable a special job to be done which is not economically feasible by other known methods.

Typical among these uses is the utilization of ultrasonics in metals joining work. It is now possible to solder, braze or weld many materials without the use of a corrosive flux or direct fusion of the parts. This can eliminate many problems which are ordinarily experienced when a fusion process or an acid type flux is used. In some cases these advantages enable a savings in material and appreciably reduce cleaning requirements. For example, parts can be ultrasonically welded close to the edge of the material and may consist of metal combinations having a wide differential in melting temperatures. Oxide removal in ultrasonic soldering, brazing and welding is automatically performed in the joining operation with minimum precleaning, limited generally to degreasing the material.

Other scientific and industrial uses provide unique advantages in:

1. Cleaning of organic soils from small or intricate parts.
2. Machining and drilling very hard and brittle material.
3. A rapid method for nondestructive testing.
4. Ultrasonic tools having high efficiency for medical therapy and dental surgery.
5. Automatic signalling and electronic devices.
6. Increased metal deposition in electroplating using an ultrasonically irradiated bath.

The functional parts of these systems and equipment

are similar, and, in some cases, have been developed to use the lower or audio frequencies to advantage. Applications of acoustic or mechanical energy over this wider frequency range can then be more properly described as sonic systems which include the ultrasonic range above 15,000 cps.

A study of some of these applications will help illustrate the possibilities and limitations of the process to aid the potential user or application engineer.

"HIGH SPEED—ROD ROLLING"

by EARLE L. CHAMBERLAIN, Division Superintendent, Hot Mills, Cuyahoga Works, American Steel & Wire Div., United States Steel Corp., Cleveland, Ohio

E. L. CHAMBERLAIN

△ IN general, the No. 1 rod mill and its facilities consist of three basic areas: (1) billet yard storage (2) No. 1 rod mill and (3) finishing and shipping.

The billet inventory comprises 3¼ x 3¼-in. x 30 ft, 1000-lb billets, which are charged from the yard or gondola car via cranes to the billet unscrambler, and thence to the 2-zone side charge and discharge type billet heating furnace.

The 4-strand mill consists of a maximum 23 stands for continuous rolling operations or 17 stands maximum for semicontinuous or looping mill operations. Continuous rolling is performed on size ranges of No. 5 rod through 27/64-in. and 15/32 in. through 1½-in. Size 7/16 through 1⅛ in. are rolled on the semicontinuous mill.

Eight enclosed laying reels are utilized in coiling No. 5 rod through 27/64-in. rod, and eight pouring reels for coiling coarse rod, running from 7/16 through 1⅛ in. Two special reels are used for rod measuring, 15/32 through 1½ in.

Coils are removed from the reels via two drag conveyors and transferred to a hook conveyor. All inspection, trimming and banding of coils is performed while the coils are traveling on the mile-long hook conveyor.

Rolling rod at 6000 fpm originally presented numerous problems which now have been largely overcome.

One of these was guide "pick-up" resulting from additional friction heat in the finishing stands. This was reduced to a minimum by using bronze receiving and twister guides in conjunction with roller twister guides, and by grinding the oval receivers with as short a bearing area as possible.

To obtain maximum production efficiency it is necessary to have a fixed metal line throughout the entire mill. Snap shears ahead of our finishing mill originally were designed to operate manually in the event of a cobble. It often was difficult to ascertain which line was cobbling, and frequently the wrong line was cut resulting in a serious pile-up. This problem has been minimized by placing four photo-electric cells with a timer ahead of the first finishing stand. If each bar rolled does not reach the reel switching within a given time, the shears automatically cut thereby reducing pile-up.

Still another problem centered around the original laying reel pipes, which would not deliver low carbon No. 5 rod to the reels satisfactorily. To overcome this, the delivery pipes were lowered to approximately the same height as the metal line of the mill; the inside diameter of the pipes in back of the finishing stand was reduced to ½ in.; vertical switching was replaced by horizontal switching; and the pipes from the switches to the reels were replaced with short ¾ in. inside diameter cast iron bell mouth pipes.

It was natural that the introduction of a rod mill of such speed and capacity would pose problems of orientation and adjustment for the crews. However, time and increasing familiarity have reduced this problem to the extent that the No. 1 rod mill has established a world production record, 515 tons of rods per turn for a month of 75 consecutive turns.

"FUNDIDORA DE FIERRO Y ACERO DE MONTERREY - MEXICO - REPORTS ON THEIR NEW COMBINATION MERCHANT BAR AND ROD MILL"

by B. R. WIBLE, Engineering Consultant to Management, and A. FERNANDEZ, General Superintendent of Rolling Mills, Cia. Fundidora de Fierro y Acero de Monterrey, S.A., Monterrey, N.L. Mexico

B. R. WIBLE

A. FERNANDEZ

△ CIA. Fundidora de Fierro y Acero de Monterrey, S. A. the oldest steel producing plant in all of Central or South America, has installed and has been operating, without outside operating technical help, for more than 2½ years a very modern, high-speed, extremely flexible merchant bar and rod mill. This mill is capable of producing some 160 sizes and types of products: namely, No. 5 rod to 3-in. diam rounds and squares; 1 x 1 x ⅛ to 3 x 3 x ⅜-in. angles and equivalent unequal leg sections; 3 and 4-in. beams and channels; flats up to 8 x 1-in.; railway products; grinding rods; concrete bar, mine rails, etc., all from 4 x 4; 6 x 3; 8 x 3 or 6 x 6-in. x 15 ft 0 in. long billets in tonnage rates from 18 to 45 metric tons per hr.

An attempt has been made to report conditions from the decision to purchase such an installation through its design requirements—mechanical and electrical supply, building design and erection, equipment installation, initial operation and production progress. Various photographs taken during these stages supplement the presentation.

The mill layout is unusual in that it has an automatic primary roughing group using 18-in. 3-high mills without tilt tables, a roller hearth multiple strand holding furnace, and a secondary roughing and intermediate or finishing group, all composed of duo-units for drive advantages and the elimination of small oval "turn-up" requirements in the repeaters.

Stands can be arranged as for a semicontinuous rod mill or a cross country merchant mill as per the finish-

ing product's demand. Six different outlets are provided for finished products. Thus, with proper progressive scheduling considerable "mill changeover" can be accomplished during production hours without interference with rolling operations.

Yield figures have been good; products are well within rolling tolerances and are produced at tonnage rates per hour as per design calculations. Overall mill efficiency has been lower than expected due to difficult scheduling conditions (which is a reflection of the present Mexican sales market), the incomplete training of the operating personnel; and various small operating "bugs" not yet eliminated.

"APPLICATION AND SELECTION OF GEAR TYPE SPINDLES"

by FRED H. PADDON, Manager of Engineering & Sales, Amerigear/Bliss Spindles, Rolling Mill Div., E. W. Bliss Co., Salem, Ohio

F. H. PADDON

△ WITH the rapid trend to eliminate high maintenance cost and quality and finish variance due to nonuniform velocity inherent with cast pod, spline and slipper type spindles on cold mills, hot mills, rod and merchant mills, tube mills, levelers and related equipment; a study of the history and growing pains of successful gear type conversions and new applications, tabulated in Table I, indicates that gear type spindles are well justified because of economies in maintenance cost, mill operating delay time and product improvement in quality, gage and finish.

Study of this gear type spindle application history, as illustrated by typical installation and spindle photographs, and sketches, indicates advantages and disadvantages of tooth and seal design, material selection, and basic spindle function as to roll change and service.

Illustrations include cutting process, actual wear patterns, and pitfalls of basic hub and sleeve teeth, followed by diagrams illustrating the effect of no load angle, full load angle and material selection.

"AUTOMATIC GAGE CONTROL ON COLD ROLLING MILLS AT DOFASCO"

by N. D. STEPHENS, Electrical Superintendent, Dominion Foundries and Steel, Limited, Hamilton, Ontario, Canada

N. D. STEPHENS

△ AUTOMATIC gage control has long been the desire of operating personnel. It was felt that under the pressure of production the strain on the rollers and their assistants was just too much to realize peak quality and quantity for eight hours.

Another area where this equipment could justify itself was in yield particularly at the ends of the coil during acceleration and deceleration of the mill.

It is desirable and profitable in tinplate business to beat the allowable tolerances and produce all material as near as possible on gage.

TABLE I
Gear Type Spindles, Application History (From Early 1950)

Application	No. applications	Roll size range, in.	Number of spindles applied			
			Modified straight tooth	Excessive crown tooth	Crowned flank tooth	Total
Cold mills						
4—High single-stand	69	4½–26	8	30	100	138
2—High single-stand	21	8–34	14	6	22	42
2 Stand tandem	4	19–21	4	0	12	16
3 Stand tandem	5	8½–21	8	6	18	32
4 Stand tandem	4	6¾–21	8	4	20	32
5 Stand tandem	4	3–23	10	0	42	52
Total—cold mills	107	3–38	52	46	214	312
Hot mills						
Rod and merchant	5	10–12½	0	0	61	61
2—High reversing	1	38	0	0	2	2
4—High reversing	4	8–32	0	0	7	7
2—Stand finishing	1	21	0	0	4	4
Vertical edger	1	36	0	0	2	2
Downcoiler	18	20–53	8	10	17	35
Wheel mill	1	16	0	0	2	2
Total—hot mills		8–53	8	10	95	113
Bridles, feed and pinch rolls	15	4–16	0	0	35	35
Continuous anneal lines	3	4–10	0	0	159	159
Leveler uncoil-recoil	52	2⅜–10	0	0	520	520
Tube, pierce and size	5	6–14	0	0	22	22
Straighteners, rim and ring mills	4	3–16	0	0	7	7
Calenders	2	—	0	0	5	5
Total history			60	56	1057	1173

The gage as applied was a new concept of automatic gage control and as applied to our reversing mill offered some real advantages over the conventional types.

This gage measures the dynamic roll gap by measuring the screw position and the pressure under the screwdown and computing the total roll opening. This is assumed to be strip thickness. These functions are computed electrically and compared with a reference voltage which represents desired strip thickness. These two voltages are compared, and a phase sensitive amplifier amplifies the error signal in such a way that it is fed back to the screwdowns to correct the error thus making a closed loop regulator.

Our company feels that after two years of operation the control has justified itself on all counts, and we are arranging to have these controls installed on our remaining three mills.

"54 YEARS OF OPERATION OF THE FIRST ELECTRIC DRIVEN REVERSING MILL"

by GEORGE H. KRAPF, Division Superintendent, Power Production, and ELMER I. PEARSON, Assistant Chief Engineer, South Works, United States Steel Corp., Chicago, Ill.

G. H. KRAPF

E. I. PEARSON

△ THE paper reviews a pioneer installation, a mill that was conceived in 1904 after experiments with available d-c motors by operators and engineers of vision and foresight who were striving to break away from dependence on steam. Layout of the mill and a review of some of the "firsts" in motor construction and control will be discussed.

The second part of the paper explains in detail the method of rewinding the main drive motor in 1958, the first rewind since installation. Because of limitation of cranes and difficulty of removing the armature from the motor room, the work was done at the site. This phase of the paper is illustrated with a large number of slides of the various stages of the rewind job.

"APPLICATION OF INDIVIDUAL DRIVE MOTORS TO MILL TABLE ROLLS"

by ANTHONY JAKIMOVICH, Application Engineer, Metal Rolling & Process Engineering, Industrial Engineering Section, General Electric Co., Schenectady, N. Y.

A. JAKIMOVICH

△ THE paper covers the advantages of the individual drive concept over that of the lineshaft drive. A series of slow speed, mill-type motors that were designed for this application are elaborated upon. This includes the electrical characteristics, application limits, as well as the mechanical mounting arrangement and ventilation scheme utilized on past installations. A section of the paper is devoted to control equipment. In this section the type of control and its requirements are discussed, with a description of the regulators and required protective equipment.

A typical blooming-slabbing mill installation is used as a guide for a sample set of calculations. The calculations are based on assumptions and considerations that are discussed in the paper such as coefficient of friction, time of acceleration and percentage of slab or ingot weight resting on an individual roll. The calculations determine the torque requirements of the motor as well as the current and voltage requirements of the generator.

Some generalities are made regarding the revamping of existing lineshaft drives to individual motor drives emphasizing the additional equipment that might be required on a typical installation.

"FIRE CRACKING IN ROLLING MILL ROLLS"

by N. R. ARANT, Technical Director, Roll Manufacturers Institute, Pittsburgh, Pa.

N. R. ARANT

△ TO determine both the present state of knowledge and the theories concerning fire cracking, an extensive survey of the literature was made by the Roll Manufacturers Institute. Furthermore, opinions and comments of men familiar with rolling mills were also obtained.

Fire cracking occurs in rolls for blooming and slabbing mills, structural mills and hot mills. This phenomena also occurs in mills for hot rolling copper, brass and aluminum. Fire cracking is sometimes considered beneficial in promoting "bite" in roughing mills. However, in most applications it is considered undesirable. Usually definite efforts are made to control fire cracking.

Rolling at abnormally heavy drafts, and rolling accidents such as "stickers," promote the starting of fire cracking. Toolmarks or sawtoothed stress raisers produced in normal machining may promote crack formation in areas stressed in tension on the surface. Continued thermal cyclic stressing deepens and widens the fire cracks already formed, and these act as notches in promoting growth. Other factors that promote crack growth include: (1) oxidation, (2) superheated steam or gas pressure, and (3) mechanical stresses such as those produced by bending.

Procedures that have helped to control fire cracking are (1) eliminating stress raisers formed during machining, (2) pre-heating the rolls, (3) using light drafts during the warm-up period of a roll to minimize contact area and bending stresses, (4) avoiding ingots or slabs "sticking" part way through the roll gap, and (5) using adequate cooling water. Rollmakers can help to a moderate extent in controlling fire cracking by providing the most suitable roll composition and heat treatment for each installation.

It has sometimes been useful to introduce surface

compressive stresses to counteract the tension stresses that cause fire cracking. This may be done by cold working the surface such as by: (1) peening, (2) knurling and (3) shot blasting. Frequent roll dressing has been used to remove a thin surface layer containing micro-cracks caused by fatigue.

"MATHEMATICAL AIDS TO DETERMINE BAR SPREAD AND REDUCTION RATES IN ROLLING"

by LOUIS MOSES, Mill Engineer, Bethlehem Steel Co., Bethlehem, Pa.

LOUIS MOSES

THE paper states that in order to obtain the full potentials of modern mill construction, improved appliances and automation generally, the engineer needs to have more knowledge of the characteristics of metal flow between rolls. The area of any rolled product emerging from any pass is a basic factor but it has been difficult to appraise with accuracy because of the apparent contradictions of spread occurring under varying circumstances. The Ekelund spread formula is applied in considerable detail to a wide range of rolling operations in demonstrating that accurate spread determinations can be made. The varying circumstances under which spreading occurs, or others when spreading is absent, are analyzed. The formula is described as an invaluable tool in the hands of the roll designer as well as a means for training assistants and learners in regard to this often elusive phase of metal flow.

The preliminary outlining of the pass areas in a series of reductions is generally tedious if not occasionally a hit and miss process. A method using multiple cycle semi-logarithmic chart paper always shows at a glance where the trend of a given progression of reduction percentages will terminate, saving much time. A series of rod mill grooves will demonstrate this graphical method which can be just as readily applied to any rolling scheme.

"REPUBLIC'S BAR MILL OF TOMORROW"

by D. E. WEAVER, Superintendent, Finishing Mills, and H. E. BERG, Chief Engineer, Chicago District, Republic Steel Corp., Chicago, Ill.

D. E. WEAVER

△ THIS paper gives an introduction to Republic Steel's new 11-in. continuous bar mill at South Chicago. It describes the design and layout of buildings, mill arrangement and auxiliary equipment as well as gives a brief account of start-up problems.

It is integrated with existing 10 and 12-in. mills to consolidate material handling maintenance, roll shop and scale recovery facilities and produces a complete line of bars as well as

H. E. BERG

coils from 450 to 1600 lb. The mill employs 16 straightaway closed top stands in alternate horizontal and vertical positions. Each stand is individually motor-driven and synchronized by electronic controls. Motors range from 300 to 800 hp. Finished bars delivered at speeds up to 3000 fpm. Two-zone recuperative reheat furnace has 100-tphr capacity and uses mixed gas or fuel oil with fully automatic fuel, pressure and temperature controls. The following equipment and operations are automatic: roll speed, up-loop vertical loopers, crop and cobble shear, cooling bed kickoff, coil handling and scale recovery. Other features of the mill include off-the-mill roll changes in a complete set of spare housings, oil-film sleeve type roll neck bearings, double staggered cooling beds and mercury vapor lighting. Major start-up problems included manpower selection, speed adjustments of stands, vertical loopers and cooling bed kickoff paddles.

"HIGH HEAD ALLOY SLAB HEATING FOR PLANETARY MILL ROLLING"

by OSCAR J. ZANATTA, Utilities Engineer, Atlas Steels Limited, Welland, Ontario, Canada

O. J. ZANATTA

△ THIS paper deals with one link in the chain which, when outstretched, forms the heating and rolling of alloy slabs into strip by the use of a planetary type rolling mill at Atlas Steels, Welland, Canada.

The slabs having a maximum thickness of $2\frac{1}{4}$ x 20 in. wide, are heated in a high head furnace by means of a high thermo potential, high velocity stream of hot gases. The heat is transferred to the slab by means of the high thermal radiation and convection of rapidly moving gases produced by the combustion of either natural gas or No. 2 fuel oil.

The specific aim of the author is to cover the design, construction, operation and maintenance of the furnace which supplies hot, uniformly heated slabs for reduction to strip coil. The furnace design, which evolved on the drawing board, was the result of many exhaustive experiments in the laboratory, in mock up models, and actual field tests.

The furnace combustion chamber is elliptical in cross section with an effective height of 3 ft 6 in., and an effective width of 21 in. A thermal release of 279,000 Btu per cu ft per hr is obtained. Each individual chamber is an integral and independent unit both structurally and refractory wise. This type of design facilitates repair because a section can be removed in its entirety. The steel chamber is lined with $4\frac{1}{2}$ in. of 2600 F insulation brick, and the inner lining is then cast around suitable forms.

The over-all length of the furnace is 108 ft and is made up of seven zones of control consisting of a total of 30 chambers. Between each chamber, placed at 42-in. centers, are located water-cooled rolls over which the

slab is transported through the furnace during the heating.

The control function for a unit of high thermal release coupled with the application of rapid heating of alloy slabs, is very precise and exacting. The primary temperature indication is obtained by sighting of a thermopile on a closed silicon carbide tube. The fuel-air ratio is maintained through a hydraulic ratio controller.

The actual furnace erection was very rapid because the chambers were cast prior to shipment from the manufacturer, and also a great deal of the assembling was done before the chambers were transported to the erection site. The furnace was completed before the mill was ready to roll. This provided valuable time for field tests and the required modifications.

The entire operation of the furnace is relatively simple and requires a total force of two. The heating curves are intended to be typical curves. Actual heating can be and is varied to achieve certain desired characteristics and results in the mill.

Maintenance of the unit is confined to failure of the water-cooled rolls due to heat and of the refractory due to damage caused by warped slabs.

The operation of this furnace has proved that:

1. The principle of high head heating is practical.
2. High head heating will produce a uniform scale-free slab for planetary mill rolling.
3. Special and complex heating equipment is not required to obtain very high thermal releases in a small space.

"SAFE CONTROL OF A MIXED GAS DISTRIBUTION SYSTEM WITHOUT THE USE OF A HOLDER"

by BURTON D. BARNS, Supervisor, Fuel and Utilities Section, Plant and Production Engineering Dept., Steel Div., Ford Motor Co., Dearborn, Mich.

B. D. BARNS

△ IN the spring of 1957 the Rouge plant was faced with the problem of operating its mixed gas distribution system without the use of a storage holder. The problem encompassed the safety of the entire Rouge plant as 500-Btu mixed gas is distributed through mains which loop the entire plant. Unsafe handling of the gas could cause not only physical damage but also result in serious loss of production. Furthermore, extreme flaring of the gas would not only be wasteful from the standpoint of the gas itself but would result in loss when more expensive substitute fuels were used during flaring periods.

With this picture in mind, controls were installed at vital points in the system. Mixed gas was distributed to the Rouge plant for 36 days without incident or loss of production.

"CONTINUOUS ANNEALING IN MOLTEN SODIUM"

by J. D. KELLER, Partner, Associated Engineers, Pittsburgh, Pa.

J. D. KELLER

△ OBJECTION to the inordinate bulk, excessive investment cost in comparison to output, and high fuel consumption of the conventional continuous annealing furnaces for sheet strip have led to the development of the sodium bath annealer. Based on laboratory tests and engineering estimates the new annealer will take up only about one-hundredth as much space, cost less than one-tenth as much, and use only one-sixth as much fuel as a conventional annealer of the same capacity.

Liquid sodium has probably the highest heat transferring capacity of any known substance. At usual strip speeds the coefficient is at least 6000 Btu per sq ft per hr per F. Sodium can cool strip as quickly as it can heat it. A travel of about 30 ft in sodium with the liquid only about 50 F hotter than the strip can effect the same heating and cooling as about 2100 ft of strip travel in the conventional annealer.

The quality of annealing is as good or better than in the conventional continuous annealers. Erichsen cup tests have shown even more favorable results than Rockwell hardness tests. The strip surface not only is not harmed but is actually improved by contact with the sodium. For this reason and because the maximum sodium temperature is so little higher than the annealing temperature, the motion can be stopped with the strip in the bath. This means that the usual looping towers and pits can be eliminated entirely.

The sodium is protected by a blanket of nonoxidizing gas. Because of the very small volume of the gas-filled space as well as the constancy of temperature, the troubles resulting from "atmosphere collapse" in conventional furnaces are eliminated here.

Many problems had to be and have been solved in the development of this process. Among them were reduction to a minimum of drag-out of sodium on the strip, sealing means, means for pumping the sodium and for removing oxide and safety precautions. Fortunately the latter had already been solved by the Atomic Energy Commission as well as by several firms making or using sodium and its alloys. The technique is developed sufficiently that liquid sodium is in daily use in regular production operations in several industries. Its acceptance by the steel industry can reasonably be predicted.

Remember the Inspection Trip!

Atlas Steels Ltd., and Strategic-Udy Metallurgical & Chemical Processes, Ltd.

Wednesday, April 29

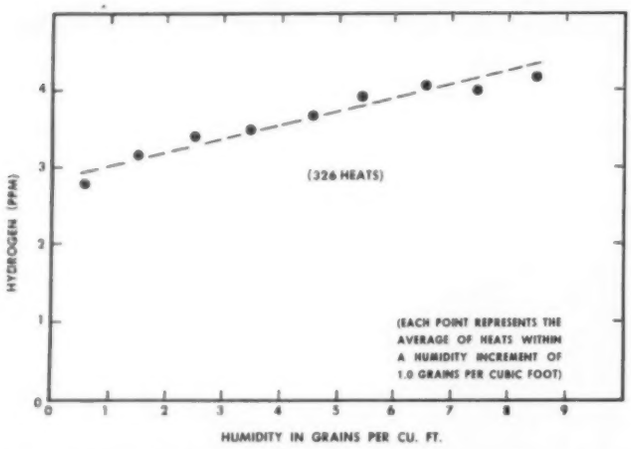

HYDROGEN (PPM)
(326 HEATS)
(EACH POINT REPRESENTS THE AVERAGE OF HEATS WITHIN A HUMIDITY INCREMENT OF 1.0 GRAINS PER CUBIC FOOT)
HUMIDITY IN GRAINS PER CU. FT.

Figure 1 — This hydrogen in metal prior to vacuum treatment vs atmosphere humidity curve is based on 326 heats.

THE possibility of improving the properties of steel products by exposing molten metal to a vacuum has been widely discussed in recent years. Increased demands for quality and high mechanical properties, especially in the field of highly stressed forgings, have presented real problems to the industry. Specifically the demand for such forgings has been particularly urgent from the electric power, atomic energy and other special industries.

Vacuum melting in small induction furnaces has been common practice for some time. There have been reports of greater product cleanliness and improvements in properties such as ductility and resistance to fatigue failure. More recently development of vacuum melting by the consumable-electrode process has received considerable attention. One of its claims is an added advantage of reduced segregation in the solidified ingots.

One of the accomplishments of vacuum melting has been particularly intriguing to producers of large forgings—the possibility of reducing the gas content of the steel, particularly the hydrogen. Hydrogen has long plagued the heavy forging industry by contributing largely to the formation of flakes in heavy sections as well as to reduced ductility. This hydrogen comes from three general sources: (1) the raw materials used in steelmaking, (2) the ingot mold and the refractories in the ladle and the hot top, and (3) the blanket of air around the molten steel, especially on humid days, as shown in Figure 1.

Figure 2 — The 120-in. ingot is one of the largest made by vacuum pouring, and the 24-in. ingot is typical of the larger sizes produced by vacuum melting.

TABLE I
Typical Analyses of Large Forgings, Per cent

Type	C	Mn	Si	Ni	Cr	V	Mo
C-V	0.40	0.65	0.20	..	..	0.05	..
Ni-Cr-Mo	0.20	0.65	0.25	0.70	0.35	..	0.60
Ni-Cr-V-Mo	0.30	0.70	0.20	2.85	1.05	0.25	0.55
Ni-V-Mo	0.25	0.65	0.20	2.85	..	0.07	0.50
Cr-V-Mo	0.30	0.85	0.25	..	1.05	0.25	1.25

Unfortunately none of the vacuum processes are capable of producing enough molten steel at one time to fill an ingot of the size needed in making heavy forgings. Approximately 6000 lb is the present limit in vacuum induction melting, 12,000 lb in the consumable-electrode process. The ingots needed for heavy forgings go up to 120 in. in diam and 500,000 lb in weight. To illustrate the huge mass of ingot required, a 120-in. ingot, one of the largest made by vacuum pouring, is shown, Figure 2, next to a 24-in. ingot, typical of the larger sizes made to date by vacuum melting.

Lacking sufficient vacuum melting capacity one would naturally look to the possibility of pouring conventionally melted steel through or into a vacuum. This method was suggested as early as 1883 (Robert H. Gordon, U. S. Patent 287273). Until recently, however, it was impractical due to a lack of pumping equipment capable of evacuating the large containers needed for the huge ingots.

In Germany the solution was sought through the use of a large battery of mechanical pumps. However, the thought of installing and maintaining large numbers of mechanical pumps was most distasteful to American engineers interested in the problem. Furthermore, the degree of vacuum reportedly attained with mechanical pumps seemed somewhat less than desired.

The attainment of a reasonably high degree of vacuum in a large volume has recently been achieved in this country through the use of multi-stage steam jet ejectors and has made possible the successful vacuum pouring of very large ingots suitable for making heavy forgings.

Typical analyses of such forgings, are given in Table I.

Vacuum Pouring

Vacuum pouring reduces the hydrogen content of electric furnace steel by 60 per cent and results in a flake-proof composition, elimination of hydrogen embrittlement, improved tensile ductility and a cleaner steel . . . . it is thus a major advance in quality steelmaking technique.

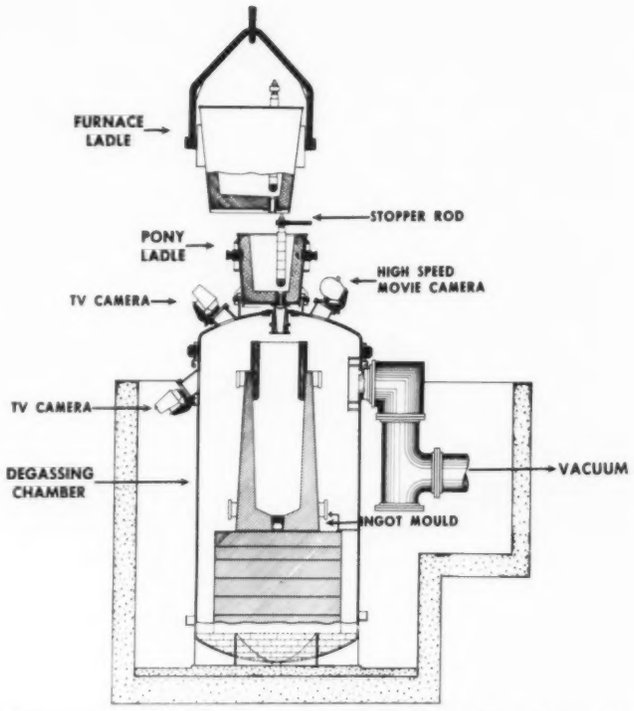


Figure 3 — Schematic shows 7-ton vacuum degassing unit capable of handling ingots of up to 40 in. diam.

Bethlehem Steel Co. decided early in 1956 to begin active development of a vacuum pouring program at its Bethlehem, Pa., plant. In order to avoid the many problems involved in starting a large 250-ton unit, which was the ultimate goal, it was decided first to build a unit of 7-ton capacity for taking the output of the 7-ton electric furnace normally used for melting highly alloyed tool steels. A unit of this size could be built and put into operation much quicker than a 250-ton unit and would provide much valuable data while the larger unit was being constructed.

Both the development unit of 7-ton capacity and the two 250-ton units provide for pouring molten electric arc furnace steel into a vacuum tank containing an ingot mold. Upon entering the vacuum the molten stream disintegrates into droplets. Gases contained in the molten metal are liberated and removed while the finely divided metal, protected from oxidation, drops into the ingot mold. The process is illustrated by the 7-ton development unit shown in Figures 3 and 4.

SEVEN-TON PILOT UNIT

The 7-ton unit, capable of handling ingots up to 40 in. in diam, proved very valuable in working out the operating features and in evaluating the benefits of vacuum pouring.

Installation of the 7-ton pilot unit was completed in 1956. It consists essentially of a 1200-cu ft tank, approximately 9 ft in diam and 19 ft high, set in a pit below floor level. The domed top of the tank is removable and sealed with a neoprene O-ring. Set on top of the domed head and sealed with a neoprene ring is a 3-ft high pony ladle having an inside diameter of about 3 ft. Its nozzle is sealed from the tank by a thin aluminum

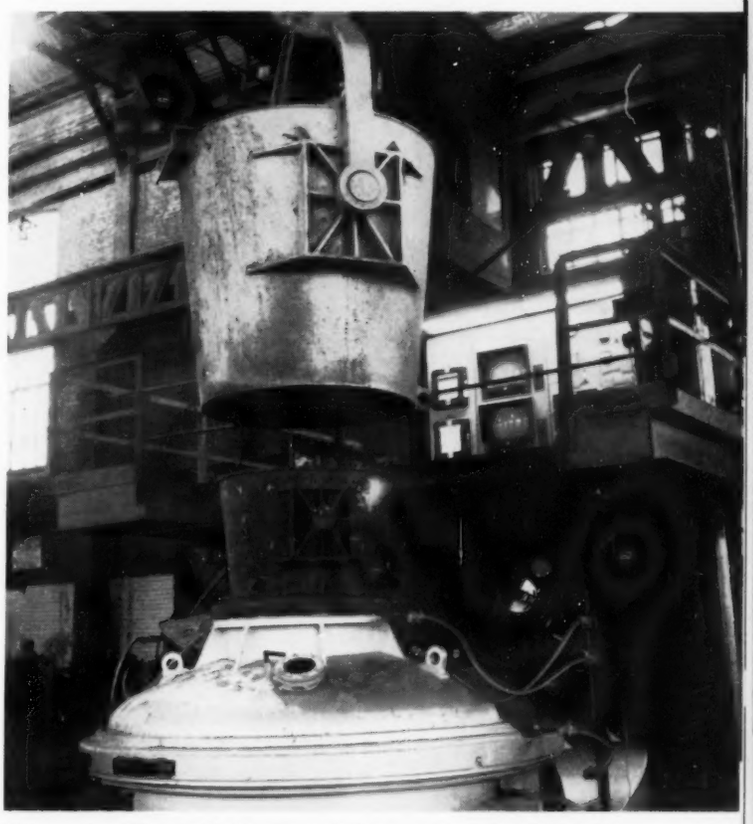


Figure 4 — The metal is poured from a furnace ladle into a pony ladle on top of the degassing unit from which it flows by gravity into an ingot mold inside the unit. This is the 7-ton unit.

For Large Forging Production

by Henry C. Bigge, Superintendent, Tool Steel & Electric Furnace Melting Depts.,
and Elliott A. Reid, Assistant Chief Metallurgist,
Bethlehem Steel Co., Bethlehem, Pa.

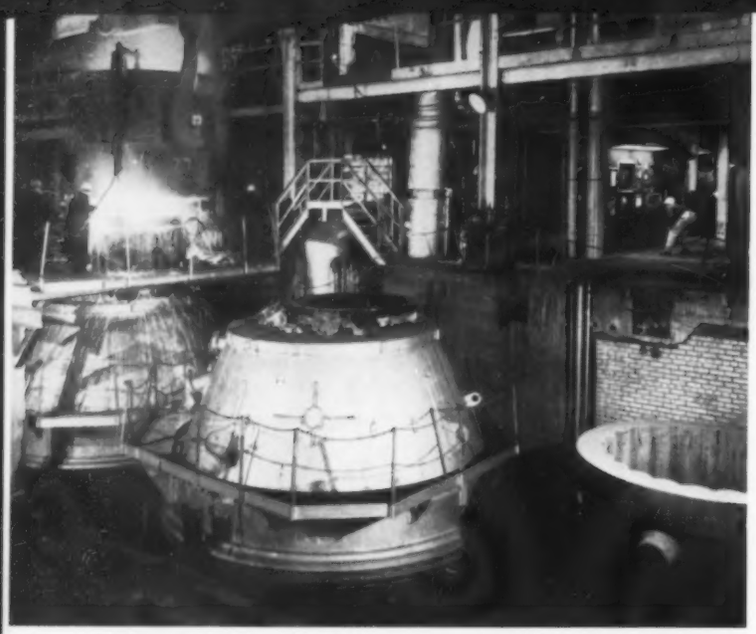


Figure 5 — Two 250-ton vacuum degassing tanks and their instrument board with gages, recorders and television monitor. Unit in front is ready for pouring.

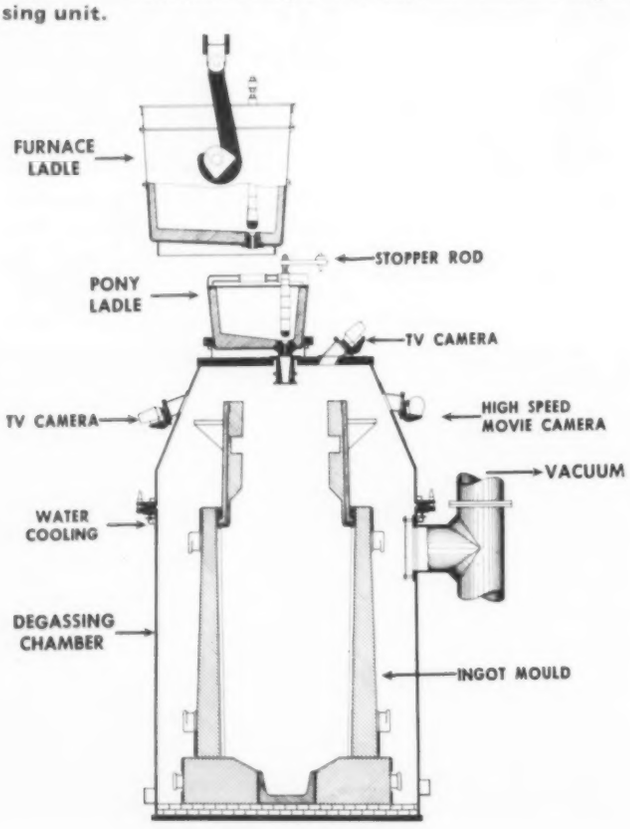
Figure 7 — These electric arc furnaces supply the two 250-ton vacuum degassing units.

rupture disk. The tank is provided with an outlet for removal of gas and has glass windowed ports for observation purposes.

The pumping unit for evacuating the tank is a 5-stage steam jet ejector which consumes about 6200 lb per hr of 125-psi steam. Steam going to the first two stages is dried and given about 50 F of superheat by an electric superheater. Otherwise ice would form in the jets where the absolute pressure attained is below the vapor pressure of ice at 32 F.

The first two stages are noncondensing, discharging steam and gases directly into the third stage. After both the third and fourth stages is a barometric condenser which condenses the steam and condensable gases while the noncondensable gases are drawn on into the following stage. The fifth stage exhausts directly to the atmosphere.

Figure 6 — Schematic diagram of 250-ton vacuum degassing unit.



In operation the ingot mold is placed in the tank at the proper level, the tank is sealed, and the pony ladle set in place. The pump is then started and the tank evacuated to an absolute pressure under ½ mm of mercury or its equivalent, 500 microns. The steel is then tapped from the furnace into a transfer ladle and moved by crane to a position above the pony ladle. The nozzle of the transfer ladle is opened and the steel poured into the pony ladle. When the pony ladle is nearly full, its nozzle is opened; the steel released melts the aluminum rupture disk beneath the nozzle allowing the metal to flow into the vacuum tank without breaking the vacuum.

EXPERIENCE WITH THE 7-TON UNIT

The experience with the 7-ton development unit proved invaluable. It not only showed the process to be practical and effective, but it also served so well in the development of practices that the first ingot subsequently cast in the larger unit was a successful regular production ingot.

Defects in the design of the steam jet pumping system were discovered and corrected. Satisfactory refractories for pony ladle lining, sinkhead lining, sinkhead packing and nozzles were developed. Techniques were perfected for proper placing of the mold below the pony ladle nozzle, for measuring temperature and degree of vacuum, for obtaining samples to measure the hydrogen level, for television viewing and high-speed motion picture studies, and for many other details of operation and co-ordination of personnel.

Based on a study of over 30 heats in this unit the following preliminary conclusions were reached:

1. The operating pressure must be low but may vary considerably in the low range.
2. Samples of molten metal from the sinkhead of the ingot showed an average of 60 per cent removal of hydrogen down to a content of 1.5 ppm obtained over a pouring range of pressures up to 1200 microns.

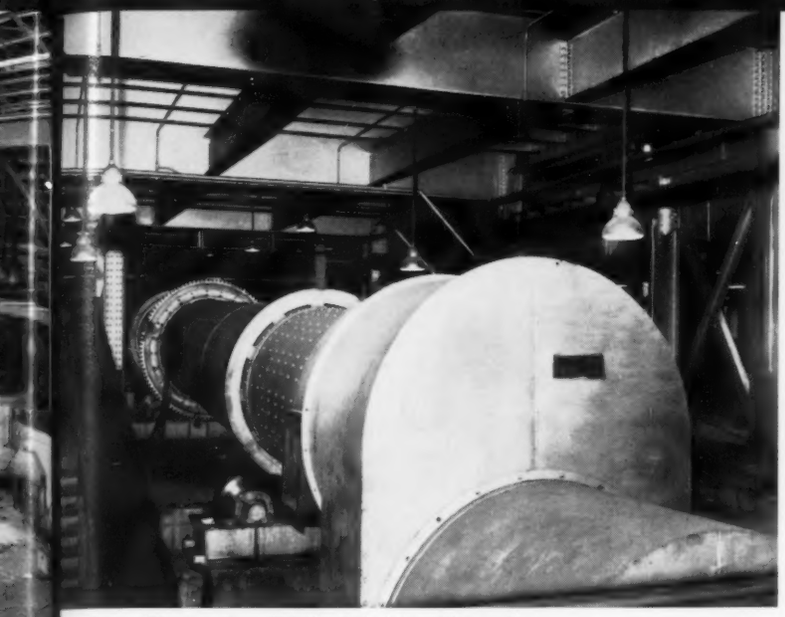


Figure 8 — Ore is dried in this unit.

Figure 9 — Single-purpose lime dryer.

3. Measured on the limited masses produced from a 40-in. ingot the sensitivity to flaking was greatly diminished.

4. During pouring the stream fans out to nearly 45 degrees from the vertical. If the distance between the nozzle and the mold is too great, the spread of the stream will make the metal fall outside the sinkhead. If the nozzle is too close to the sinkhead, the metal will not be properly degassed.

250-TON PRODUCTION UNIT

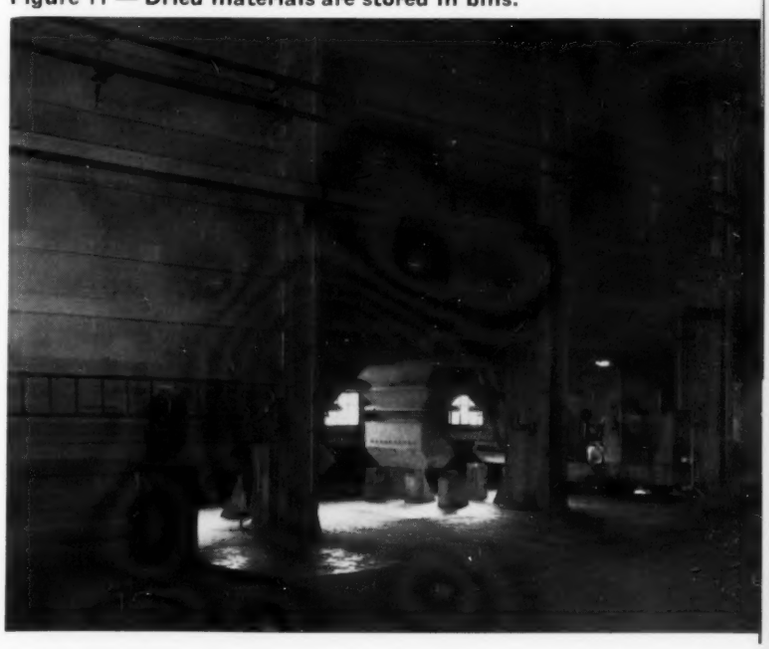
The 250-ton unit was completed in July, 1957, and placed in regular production immediately. With minor modifications it is a scaled-up version of the 7-ton development unit. Success of the new unit was so quickly demonstrated that a second identical tank was constructed and put into operation in January, 1958. These tanks use a common pumping system alternately. The two units are capable of handling ingots up to 120 in. diam, weighing 500,000 lb. Under normal conditions production will average 26 to 28 ingots a month, Figures 5 and 6.

The two units are installed in the electric furnace melting department which has five basic arc furnaces, Figure 7, one of 28-ton and four of 50-ton capacity. Their bottoms are lined with magnesite brick and covered with a 6½-in. layer of rammed magnesite. Roofs are of high-alumina brick and fitted for 20-in. diam graphite electrodes. Automatic regulators control the power input from 10,000 and 18,500-kva transformers.

All ore, alloys and fluxes used in the electric furnace heats are dried to remove hydrogen from that source. Over a number of years the hydrogen content has been maintained at an average of 3.4 ppm. Ore, fluorspar and sand are dried at 300 F in a rotary kiln, lime in a rotary drier capable of heating to 1500 F, and alloys in charging boxes placed in a hearth furnace operating at 1400 F. Drying facilities are shown in Figures 8, 9, 10 and 11.

Figure 10 — Alloys are dried in this furnace.

Figure 11 — Dried materials are stored in bins.



MELTING AND REFINING

Steel for heavy forgings is made by double-slag practice—a basic slag of lime and fluorspar followed by

a reducing slag made up with lime, sand, fluorspar, graphite and silicon carbide in the approximate ratios 30:3:2:2:4. Ferromanganese is used for deoxidation after slag-off and ferro-silicon before tap. No aluminum is used for deoxidation.

Immersion pyrometers are used to measure the temperature in the furnaces, the ladles and the ingot molds. Depending upon the grade of the steel, a pre-slag temperature ranging from 2950 to 2980 F is used with tapping temperatures from 2875 to 2920 F. All furnaces are equipped with automatic temperature recorders.

Production of multiple heat ingots weighing up to 500,000 lb naturally creates certain timing and scheduling problems. On the other hand, definite advantages may also accrue from the multiple heat practice. By varying the carbon content in the various heats, the tendency to excessive carbon segregation in the top of the ingot may be counteracted, insuring an ingot of relatively uniform composition. In producing a 120-in. ingot, for instance, the bottom heat may be set for 0.25 carbon, the second for 0.23, the third for 0.21, the fourth for 0.20, and the sinkhead heat for 0.18 per cent carbon.

Welded tapping ladles of conventional construction, of 50 and 85-ton capacity, are used. They are lined with high quality alumina fireclay brick and are dried for 8 hr after lining. To prevent the 12½-ton pony ladle from overflowing should the stopper rod in the furnace ladle be lost, the pony ladles are equipped with an extra nozzle.

Ladle nozzles are saturated in tar for 72 hr at 260 F, dried the same length of time at 460 F, wire-brushed and ground on the stopper rod seat. This insures good shut-offs and freedom from leaky nozzles.

Round corrugated molds of one-piece design with 24 corrugations are used. With this design the sinkhead is set down into and anchored to the mold giving maximum flexibility of ingot weights for a given mold. After completion of the pour the holding pins are released to allow the sinkhead to settle with the shrinkage preventing hanger cracks.

Standard pit practice calls for careful inspection of ladles, nozzles and molds. In pouring multiple heat ingots, the furnace schedules are arranged to allow enough time in the ladle for proper clean-up without loss in temperature. Temperature readings are taken during the tapping of each furnace, throughout the pouring of the furnace ladles and the pony ladle, and at the seal when the metal reaches the base of the sink-

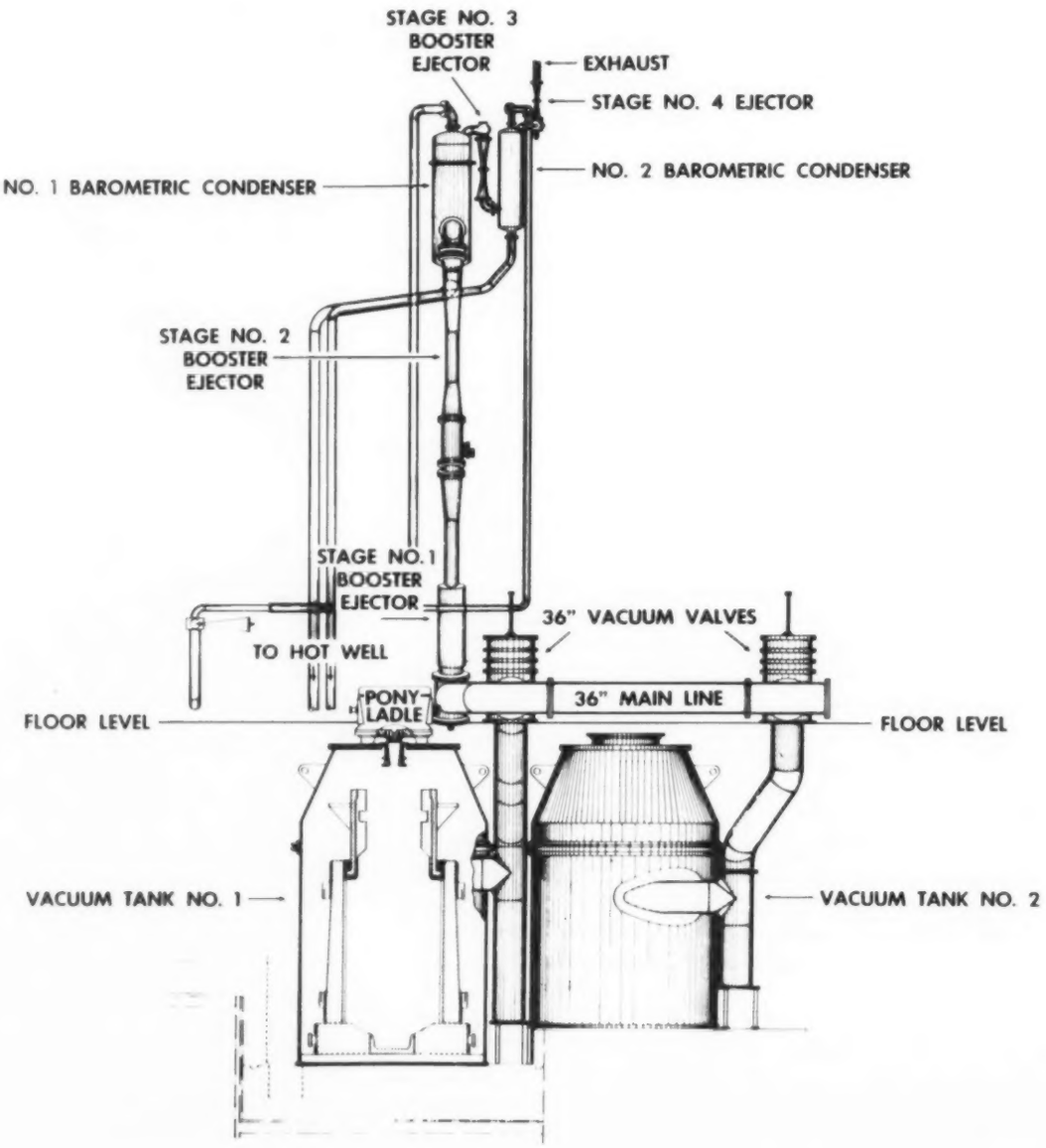


Figure 12 — This steam jet ejector system degasses the 250-ton vacuum units.

head. Typical readings are 2910 F tap temperature, 2820 F pony ladle temperature and 2760 F seal temperature. Chemical analyses, including hydrogen determination, are standard for all heats.

Holding time before stripping is about 0.5 hr per in. diam of ingot. The sinkhead flask is removed about 4 hr before stripping to give the lifting lugs on the sinkhead a chance to cool.

The vacuum tank is made in two parts, a stationary straight bottom of 15 ft-6¼ in. inside diameter, 19 ft-2 in. high, and a tapered removable dome of 10 ft-8 in. diam at the top and 8 ft-7½ in. high, making the overall height of the tank 27 ft-9½ in. The tank is made of 1½-in. plate except for the top of the dome, which is 6-in. plate. Vacuum seals are provided by neoprene "O"-rings between the two sections of the tank and between the pony ladle and the top of the closure head. In both cases the flanges are water-cooled to protect the rings. Provisions are also made for running water over the outside of the tank to protect it from excessive heating while the ingot is solidifying.

Observation ports in the dome permit visual, television and motion picture viewing of the hot metal stream from various angles during pouring. An aluminum rupture disk seals the tank from the nozzle of the pony ladle while the tank is being pumped down and checked prior to pouring.

The vacuum equipment will evacuate 318 lb per hr of 19.3 molecular weight gas at 212 F and 1000 microns (one mm Hg abs.). It is produced by a 4-stage steam ejector system designed for 450 F and 135-psi min pressure. The first stage pump is noncondensing. Barometric condensers after the second and the third stages reduce the volume of steam and gas in the succeeding stages. The fourth and final stage exhausts to the atmosphere, Figure 12.

The steam ejectors work on a mass-velocity principle wherein the steam passing through the jet is alternately expanded and compressed, picking up the gas and vapor from the vacuum line on its way through. Lower capital and maintenance cost were the deciding factors in favoring the selection of the steam ejector, a choice that has been fully justified.

The specifications of the steam jet system are given in Table II.

In putting the ejector system into operation a carefully arranged sequence is followed in which the fourth stage is started first. Then each subsequent stage and intercondenser, working toward the first stage, are placed in full operation and carefully checked before the next is turned on. When the last three stages are operating effectively, the pressure in the tank will be approximately 3 to 5 mm mercury. With all stages operating, the pressure in the tank will drop to below 500 microns, or less than ½ mm mercury.

TABLE II
Specifications of The Steam-Jet System

Operating pressure (microns Hg abs.)	1000
Air capacity (lb per hr)	318
Steam pressure (psig)	135
Steam quantity (total lb per hr)	8900
First stage	970
Second stage	4395
Third stage	1245
Fourth stage	2290
Condenser water-quantity-total (gpm)	850
Condenser water-inlet temperature (F)	90
Condenser water-outlet temperature (F)	107
Actual steam quantity, (lb per hr)	9700

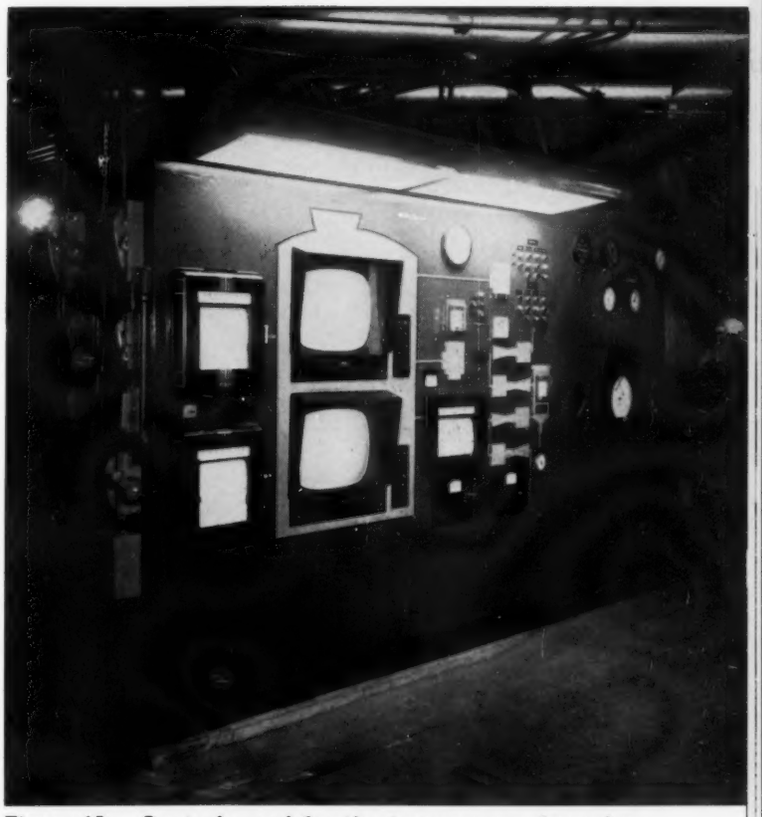


Figure 13 — Control panel for the two vacuum degassing units (television monitors are on the left side of the panel).

The condition of the stream may be followed at all times by means of two high-speed television cameras, one directed toward the pouring nozzle, the other into the mold. These cameras record the results of all operational changes in setup and pouring, for study and evaluation.

Instrumentation for the unit is a most important

Figure 14 — Closeup of television monitors on control panel.

feature for successful operation, Figures 13 and 14. Included are steam gages for measuring pressure and consumption, water gages for measuring consumption in the condensers, thermometers for measuring inlet and outlet water temperatures, and thermocouples for measuring hot metal temperatures and for showing when the metal reaches the seal in the ingot. Accurate measurement of vacuum is quite difficult with respect to both locating and maintaining the sensing elements. Three different types of conventional vacuum gages are used, one utilizing radium, the two others hot filaments.

In operating the vacuum unit careful attention must be given to preparation of the tank and the mold in the tank. The tank, stools and vacuum lines must be carefully cleaned of oxide and dust. The ingot mold must be cleaned of all oxide, preheated and placed on the stool in the tank at a predetermined distance below the pony ladle nozzle. The sinkhead must be lined with high quality alumina brick and cement capable of withstanding a minimum temperature of 3000 F as well as the erosion by hot metal; it must be very thoroughly dried for 24 hr above 1000 F.

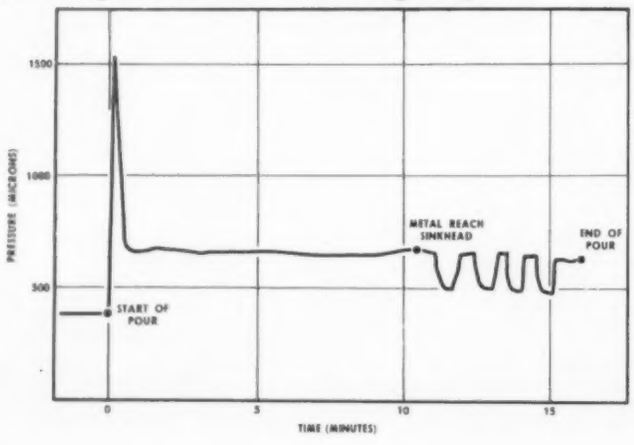
The packing of the joint between the mold and sinkhead presented a problem. It must have good ramming properties so that it will seal the juncture effectively and prevent hot metal from cutting through the seal and running down into the tank. At the same time the sealing material must resist being pulled out by the vacuum and yet be easily removed later in stripping the sinkhead. In one early trial it was found that pumping down the tank had not only removed most of the gas from the tank but also most of the sealing refractory. Finally the mold must be siphoned to remove loose particles of dust or refractories before the dome and the pony ladle are placed on top of the tank.

POURING INGOT

With the tank held at the desired vacuum level, steel is tapped from the electric arc furnace, and the furnace ladle positioned over the pony ladle. The pony ladle is filled and the stopper rod raised. The hot steel immediately melts the thin aluminum rupture disk and enters the vacuum tank. Liberation of gases in the steel causes the stream to fan out in a cone shape and disintegrate into droplets which fall into the mold.

A typical log of the pressure during the pour of a 92-in. ingot is shown in Figure 15. The original pressure of about 400 microns jumps to about 1500 microns at the first influx of hot metal but recovers quickly to about 600 microns and remains reasonably constant until the metal rises to the sinkhead as indicated by the increased temperature of a thermocouple at the seal. There is some fluctuation during the filling of the sink-

Figure 15 — Typical pressure curve during pouring of a 92-in. ingot in a 250-ton vacuum degassing unit.



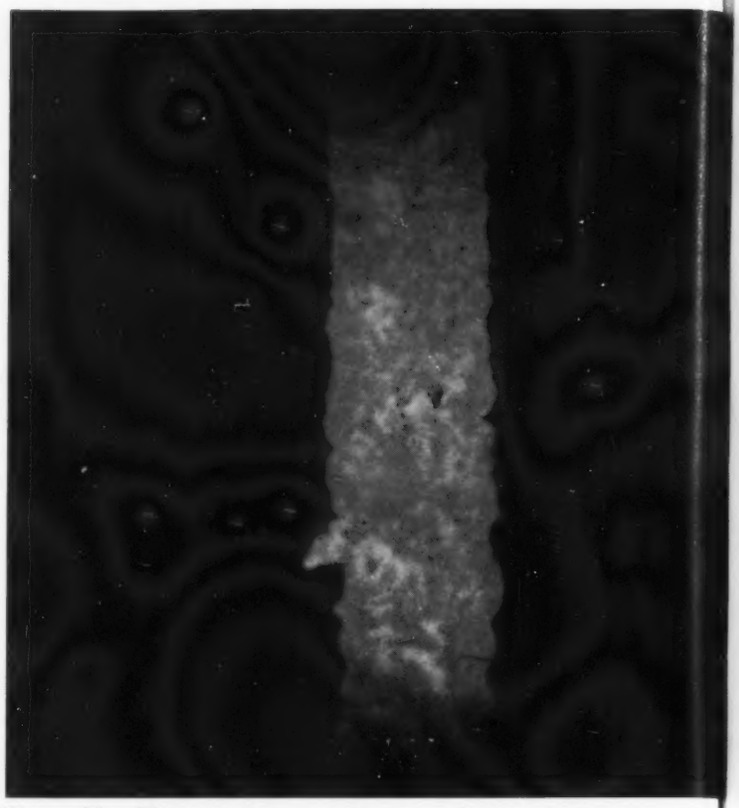
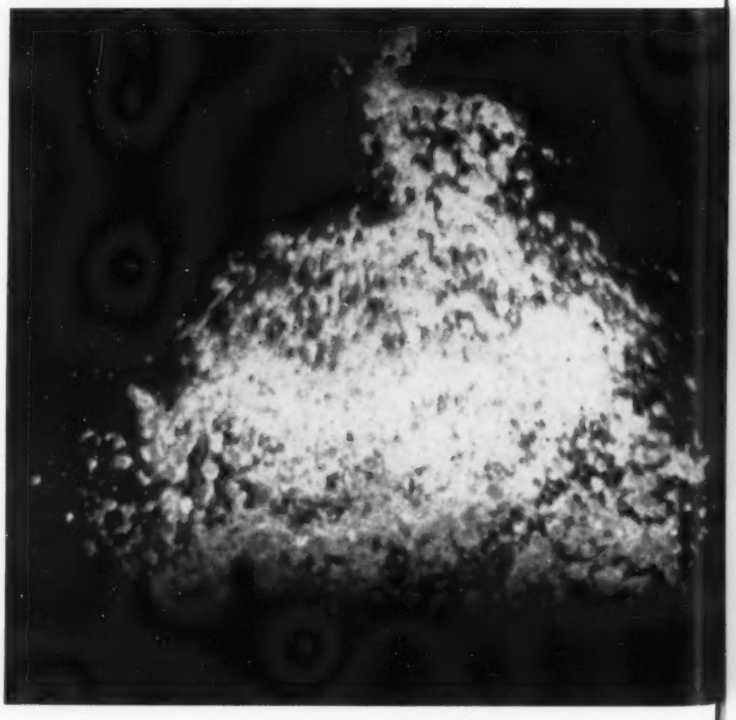


Figure 16 — The metal stream of a normal pour at atmospheric pressure is kept tight in order to minimize oxidation of the metal.

Figure 17 — In contrast to normal pouring the vacuum-poured stream disperses permitting the release of gases dissolved in the metal.



head due to the intermittent pouring at this stage.

Due to the rolling action of the metal under low pressure it is important to take extra care to prevent metal from spilling into the tank during the filling of the sinkhead. By cutting out some stages of the vacuum system the tendency to roll may be largely overcome.

When pouring is completed, the vacuum line valve is closed and 100 to 200 cu ft of argon bled into the tank to dilute the combustible gases and prevent possible explosion when air is subsequently admitted. In the meantime the pump is shut down, starting with the first stage and then proceeding with subsequent steam jet stages, reversing the order in the starting sequence.

The pony ladle is quickly removed to permit taking a sample from the sinkhead for hydrogen determination. Comparison with samples taken from the pony ladle gives the efficiency of the hydrogen removal. The pouring platform and the dome are removed as soon as possible to prevent overheating.

The ingot is allowed to solidify in the tank with water running over the outside of the tank shell to keep it cool. A 120-in. ingot requires 60 hr to solidify, with shorter time for smaller ingots. While an ingot is solidifying in one tank, another may be poured in the second tank.

In normal pouring at atmospheric pressure, every attempt is made to obtain a tight, rope-like stream, as shown in Figure 16, in order to minimize oxidation and improve cleanliness in the ingot. In contrast the stream in vacuum pouring, shown in Figure 17, spreads over a wide area, facilitating the release of gases dissolved in the metal.

High-speed motion pictures of the vacuum stream show how bubbles form and finally burst as the gases come out of solution. In Figure 18 are shown three frames from the film. The large globule in the upper frame starts to collapse in the second frame and has completely burst in the third frame.

A typical analysis of samples of gas taken from the vacuum line shows hydrogen, 31 per cent; nitrogen, 36 per cent; carbon monoxide, 29 per cent; and carbon dioxide and oxygen, four per cent. The effect of the vacuum on hydrogen in the product is well understood while that on oxygen and nitrogen is not so clear. Published information on this subject is at variance. Since our main interest is in hydrogen, we have concentrated on that element and have not yet obtained sufficient data on the other gases for drawing definite conclusions.

Comparison of the tests on the metal in the pony ladle and in the sinkhead shows an average of 63 per cent of the hydrogen removed. The removal in the 250-ton unit was about the same as in the smaller 7-ton unit.

The percentage of hydrogen removed and the spread experienced is shown in Figure 19. As present day accuracy in hydrogen analysis is at best plus or minus one half ppm, any hydrogen figure should be considered with that limitation in mind. Whereas one laboratory may reproduce results with reasonable accuracy, the reproducibility among different laboratories is less exact.

The relation between the degree of vacuum and the hydrogen removal is shown in Figure 20. The relatively flat and straight lower line, representing the hydrogen content in ingots poured between 400 and 1200 microns, indicates effective hydrogen removal in pouring anywhere within this range. Obviously, considerable latitude is permissible in the selection of satisfactory operating conditions.

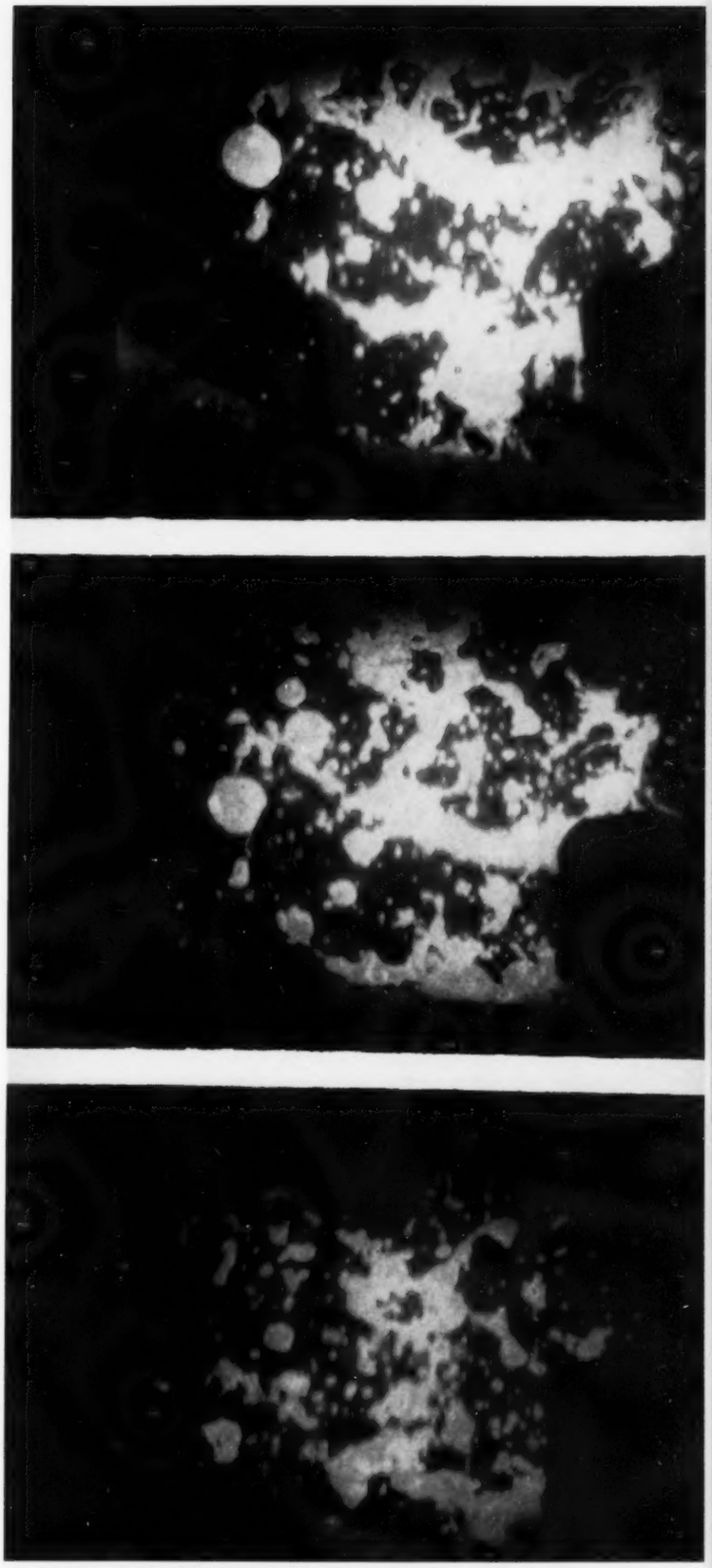


Figure 18 — High-speed motion pictures of the vacuum stream show how bubbles form and finally burst as the gases come out of solution. The large globule in the top frame starts to collapse in the middle frame and disintegrates in the lower frame.

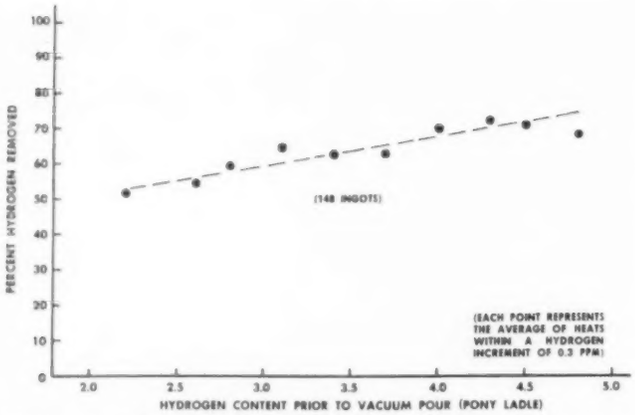


Figure 19 — The per cent of hydrogen removed by vacuum pouring depends on the hydrogen content of the metal prior to pouring.

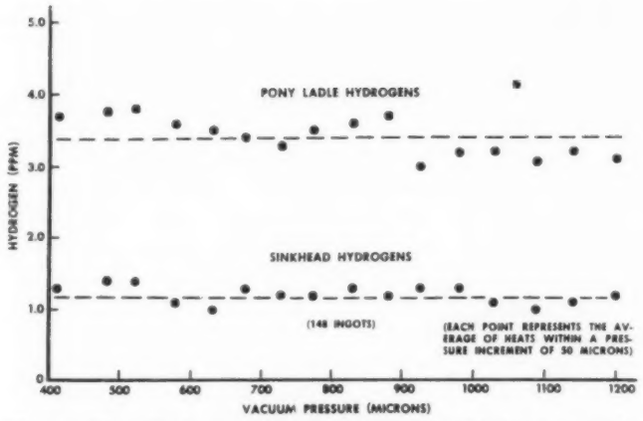


Figure 20 — Hydrogen removal can be obtained equally well anywhere in the vacuum pressure range of 400 to 1200 microns.

Figure 21 shows a 120-in. ingot being stripped from a mold in one of the vacuum tanks. After stripping, the ingot is shipped to the forge where it is heated, press-forged and given a conditioning heat-treatment prior to rough machining, final heat-treatment, testing, finish machining and extremely critical inspection.

RESULTS OBTAINED THROUGH VACUUM POURING

It is quite clearly established that the hydrogen content of the steel in large forgings is materially reduced by vacuum pouring. This is important because the hydrogen content has been found to be a principal factor in the tendency for large sections of wrought steel to flake despite extreme precautions in cooling the steel to room temperature. It is also important because hydrogen causes embrittlement which cannot be completely eliminated by heat-treatment when the steel section is large.

Great effort has been expended by melters of forging steels to minimize the hydrogen content by resorting to tactics such as obtaining an active boil during the oxidation period and thoroughly drying all materials added to the furnace during the refining period. These stringent measures have achieved an average level of 3 to 4 ppm of hydrogen in electric arc furnace steel as shown by the first bar in Figure 22. Subsequent forging and heat-treatment operations reduce the hydrogen in the outer portions of a forging as illustrated by the second bar. However, the hydrogen in the center of the forging remains at a level nearly as high as that in the original molten steel as shown by the third bar. In contrast, the next group of bars shows that the hydrogen in the steel is reduced by vacuum pouring from an average between 3 and 4 ppm to a level of 1 to 2 while that in the forging made from it is at a level of less than one ppm throughout the section.

FLAKES IN HEAVY FORGINGS

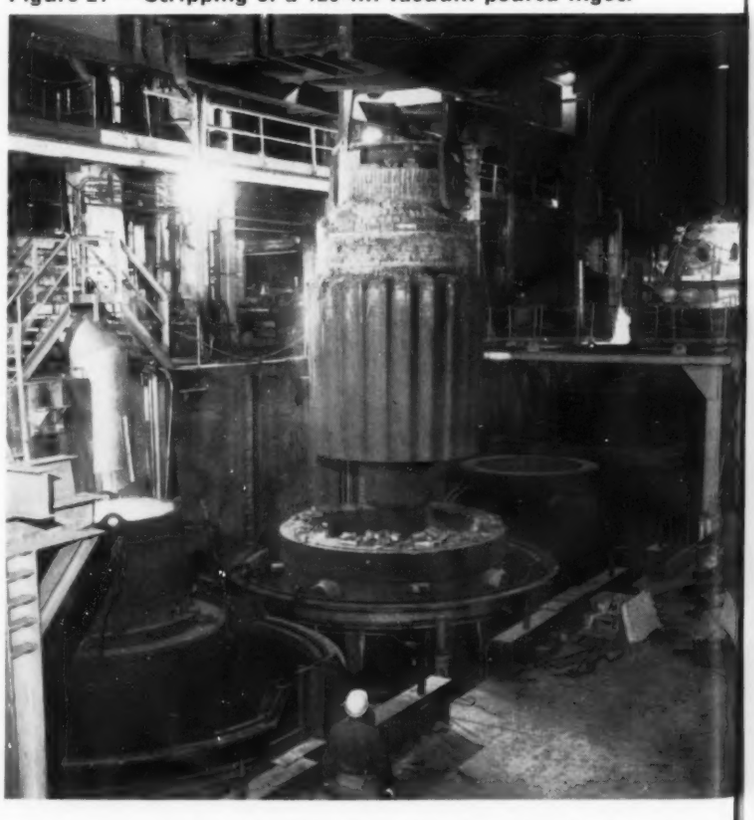
Some types of steel used in heavy forgings are prone to flaking despite extreme measures of heat-treatment in cooling the forging to room temperature. Treatment cycles of a month or more are common. Figure 23 shows the magnafluxed cross section of a Ni-V-Mo steel turbine rotor which flaked even after such precautionary treatment. By way of contrast, an experimental forging of the same size and composition made from vacuum poured steel has been air cooled directly from the press. Destructive testing showed no flakes whatsoever.

In actual production direct air cooling would never be practical because the heat-treatment following forging is necessary to provide homogeneity and refinement of structure. However, the freedom to devise heat-treatments for maximum refinement without concern for flakes is of inestimable value to the heavy forging producer and a great relief to the mind of the user.

MECHANICAL PROPERTIES

The presence of hydrogen in normal concentrations gives an embrittling effect to many compositions of steel. Peculiarly enough, this embrittlement does not manifest itself when stress is applied rapidly as in an

Figure 21 — Stripping of a 120-in. vacuum poured ingot.



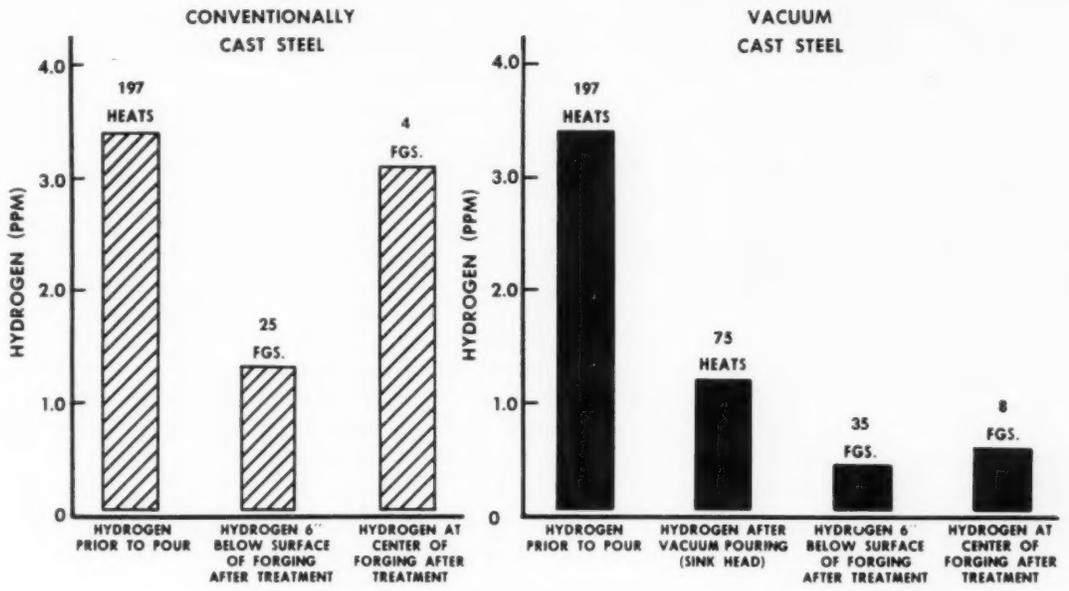


Figure 22 — Only the hydrogen content of the extremities of a normally poured ingot is reduced by heat-treating and forging whereas the hydrogen content of the entire ingot is reduced by vacuum pouring.

impact test. But it has a marked effect in reducing the ductility of steel subject to a more gradual stress application as in a tensile test. In small cross sections the hydrogen is easily reduced to a concentration below that necessary for embrittlement, and this reduction occurs in the normal course of processing. But in the large cross sections no method has been found to overcome the embrittlement once the hydrogen is present. As a result, this kind of embrittlement has become recognized as a necessary evil, and it has long been commonly accepted practice to age tensile test specimens from large forgings at a temperature of 200 to 500 F to reduce the hydrogen embrittlement prior to testing.

Vacuum pouring eliminates this anomaly as demonstrated in Figure 24. Here it is seen that the elongation and reduction values for conventionally handled Ni-V-Mo forgings are appreciably lower when tests are not aged. On similar vacuum poured forgings the aged and non-aged tests show entirely comparable ductility values. This graph also demonstrates another bonus of vacuum pouring. A comparison of the elongation and reduction values for the two types of steel shows that vacuum poured steel gives a considerably higher level of ductility regardless of the aging of test bars. Experience to date also indicates better consistency of results.

Needless to say, elimination of the necessity for aging test bars and the attainment of higher ductility levels are extremely valuable contributions of the vacuum pouring process.

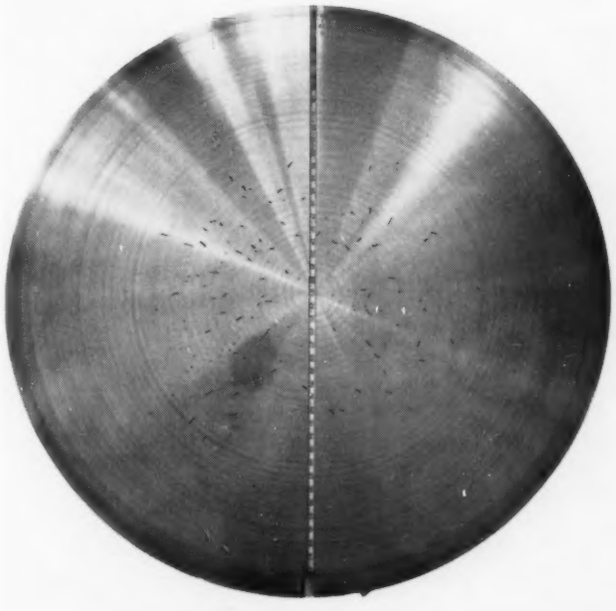
CLEANLINESS

It is difficult to measure relative cleanliness of large forgings because the usual macroetch and cross-section fracture tests are impractical and microratings are of questionable value even in small sections, let alone large ones, because of nonrepresentative sampling. The best measure seems to be a rating of the nonmetallics appearing on the fracture of tensile bars. An empirical rating system was used to obtain the data used in preparing Figure 25 which compares the tensile bar fracture rating of vacuum poured and conventionally poured forgings. It is apparent that the rating of inclusions on the conventionally poured steel is much higher and covers a much wider range. Note that the vacuum cast steel consistently shows a very low inclusion rating.

Supplementing the fracture ratings with microscopic studies of inclusion types has indicated that silicate-type inclusions are less numerous and smaller in the vacuum poured product. Other types of inclusions appear to be unaffected.

The natural processes of soldification of the ingot are not appreciably affected by vacuum pouring. Therefore, there is no reason to expect material improvement in the massive segregation and sulphides common in large ingots. Observations to date seem to bear out this expectation. Minimizing segregation and healing of normal ingot porosity still must depend on

Figure 23 — Even heat-treatment cycles of over a month for lowering the temperature of the forging to room temperature are ineffective in preventing flaking in some types of steel as this cross section of a Ni-V-Mo steel turbine rotor shows.



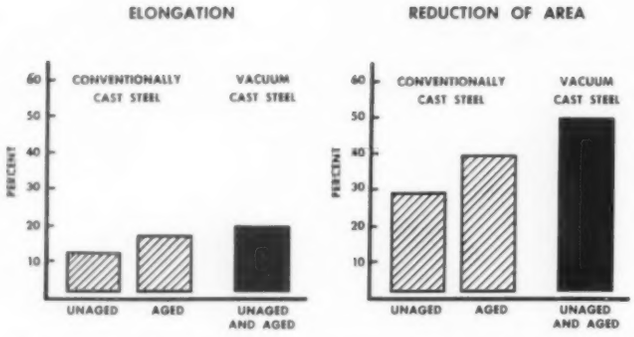


Figure 24 — Conventionally poured forgings have higher tensile strengths after aging whereas the higher strength vacuum poured forgings require no aging.

techniques involving ingot practice, forging reduction and forging procedure.

EFFECT ON OTHER PROPERTIES

The effect of vacuum pouring on other properties of interest to users of large forgings is still in process of investigation. There is some evidence of improvement in the level of transverse impact test values but the transition temperature determined by rating the proportion of ductile fracture on impact specimens appears to be little affected. Evaluation of elevated temperature properties, fatigue resistance and magnetic properties has not yet progressed to the point where any conclusions can be drawn.

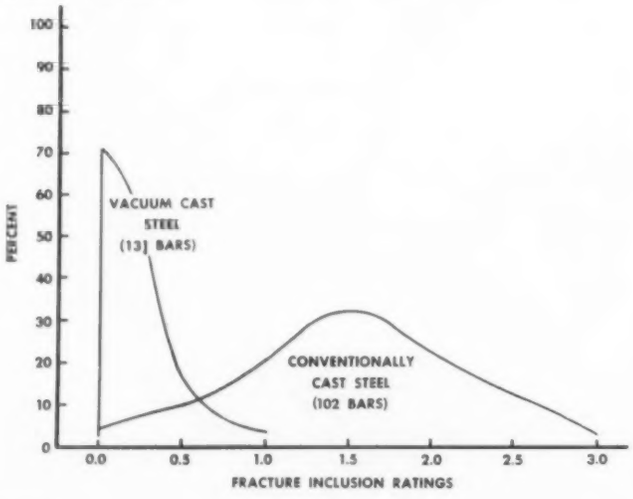
SUMMARY OF VALUE OF PROCESS

The worth of the vacuum pouring process has been clearly and firmly established. A process which enables producers to manufacture large forgings of flake-proof compositions with assurance that no flakes will occur if the forging is properly handled is in itself of inestimable value to both producers and users of the product.

The elimination of hydrogen embrittlement in large forgings, something which could never before be accomplished in some compositions, makes vacuum pouring a must in the eyes of users of certain forgings which are critically stressed in service.

When one adds to these advantages the extra features of improved tensile ductility and greater cleanliness of product, it is clear that vacuum pouring is a major advance in the heavy forging industry.

Figure 25 — These distribution curves, based on an empirical rating system, compares the fracture inclusion ratings on Ni-V-Mo conventionally poured and vacuum poured ingots.



STATUS OF THE VACUUM POURING PROCESS FOR HEAVY FORGINGS

It appears certain that the use of vacuum pouring of ingots for heavy forging production will grow rapidly. While it is far from a solution for all the problems of heavy forging manufacture, it comprises a major step toward the attainment of a higher quality product.

The advantages gained are, of course, not won without added cost and hazard. In addition to heavy capital expenditure for equipment, there are appreciable added costs for special refractories and other materials and for extra labor in preparing molds, ladles and vacuum equipment for every ingot poured. The hazards involved from the standpoints of both loss of ingot and damage to equipment necessitate the most meticulous care in preparation and operation of the vacuum facility.

The greater assurance of a sound product, the better mechanical properties and the improved cleanliness are well worth the added cost and hazard when critical application is involved.

By the end of 1958 Bethlehem had produced large vacuum poured ingots and looks forward to still further expansion in application of the product to meet the ever increasing demands for higher quality forgings.

Discussion

PRESENTED BY

E. J. BORREBACH, Steel Mill Engineer, Industrial Engineering Dept., Westinghouse Electric Co., East Pittsburgh, Pa.

ELLIOTT A. REID, Assistant Chief Metallurgist, Bethlehem Steel Co., Bethlehem, Pa.

MORRIS STONE, Manager, Development, United Engineering and Foundry Co., Pittsburgh, Pa.

JAMES M. FORD, Superintendent, Midvale Heppenstall Co., Nicetown, Philadelphia, Pa.

HENRY C. BIGGE, Superintendent, Tool Steel & Electric Furnace Melting Depts., Bethlehem Steel Co., Bethlehem, Pa.

MICHAEL OREHOSKI, Research Associate, Applied Research Laboratories, United States Steel Corp., Monroeville, Pa.

E. J. Borrebach: Several manufacturers employ electric arc hot topping for the production of large castings such as mill rolls. With an air casting there is no problem in positioning and operating such electrical equipment. However, to employ this equipment with a vacuum casting would require stripping of the vacuum enclosure shortly after the pour had been completed. Do you presently employ a hot top method that does not require such stripping? Could you carry out this stripping of the enclosure if necessary right after the

pouring has been made in order to permit the use of an electric arc hot top?

Elliott A. Reid: There is, of course, a sinkhead on these large ingots which is built up of refractory brick in a steel shell. Also exothermic or refractory materials are sometimes placed on top of the sinkhead to help the insulating characteristics.

We have done no electric hot topping but I see no reason why it could not be done from a mechanical standpoint. We remove the dome rather quickly after finish pouring and, on any electric hot topping operation, there is always a time interval between finish pouring and turning on the power for the hot top.

Member: Speaking of hot topping practices, have you found any difference in the piping characteristics of vacuum cast and air cast steel?

Elliott A. Reid: Yes, there does seem to be a greater tendency for piping in the vacuum cast ingots. We have had to compensate for this by using sinkheads of slightly greater volume and height.

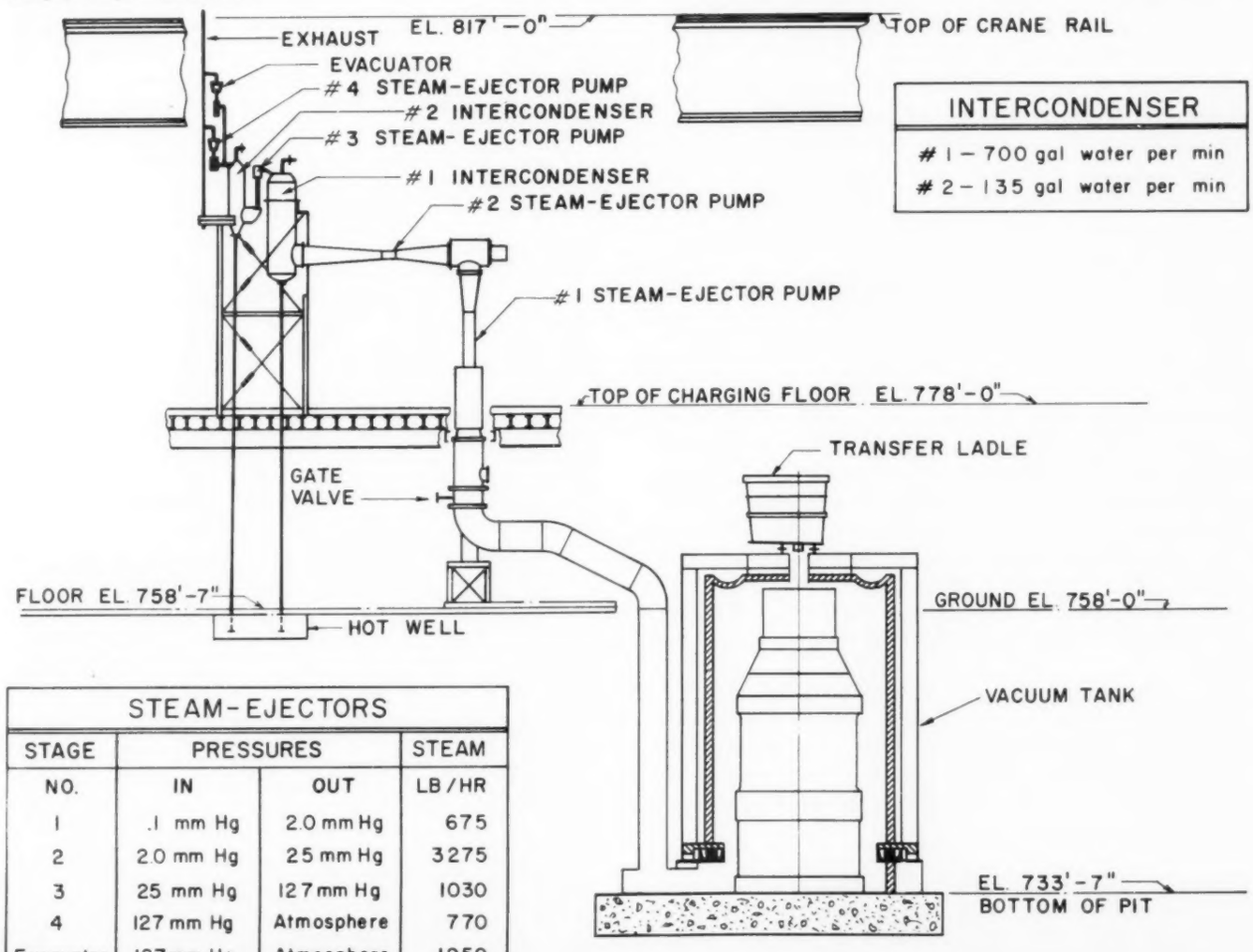
In early experience, it was found necessary to increase the throat diameter of the sinkhead to facilitate one of the features of the vacuum operation. In so doing, we maintained the same sinkhead volume, which meant decreasing the height of the sinkhead. With this lesser ferrostatic head, the feeding of the ingot was impaired, and excessive porosity was obtained.

Morris Stone: Can you give us an idea of how much more expensive forging will be with vacuum degassing compared to conventional practice? Have you investigated the possible use of vacuum degassing in basic or acid open hearth steels, and would you recommend it?

Elliott A. Reid: With regard to the first question concerning added cost, we have not yet been able to accurately evaluate the over-all picture. Definitely there are added costs for equipment and for operating. Some of the extra operating costs can be easily broken out while others are less clearly separable. On the other side of the ledger, you have a more sound product with fewer condemnations to help balance some of the added costs. At this time, we are not in position to cite figures which have factual bases. It should be recognized, of course, that the product is materially improved, a factor which is important in any cost consideration.

As to the second question, there is no doubt that the same reduction in hydrogen content could be accomplished by vacuum degassing of basic or acid open hearth steel. We have not tried it because we are operating only basic electric arc furnaces in the shop where the vacuum equipment is located. I might add that our practice on heavy forgings for the most part involves the use of electric furnace steel, and I doubt that we will have occasion in the near future to try vacuum degassing of open hearth steel.

Figure 26 — Vacuum pouring facilities on the pouring pit side of the electric furnace department at United States Steel Corp., Duquesne Works.



STEAM-EJECTORS			
STAGE	PRESSURES		STEAM
NO.	IN	OUT	LB/HR
1	.1 mm Hg	2.0 mm Hg	675
2	2.0 mm Hg	25 mm Hg	3275
3	25 mm Hg	127 mm Hg	1030
4	127 mm Hg	Atmosphere	770
Evacuator	127 mm Hg	Atmosphere	1950

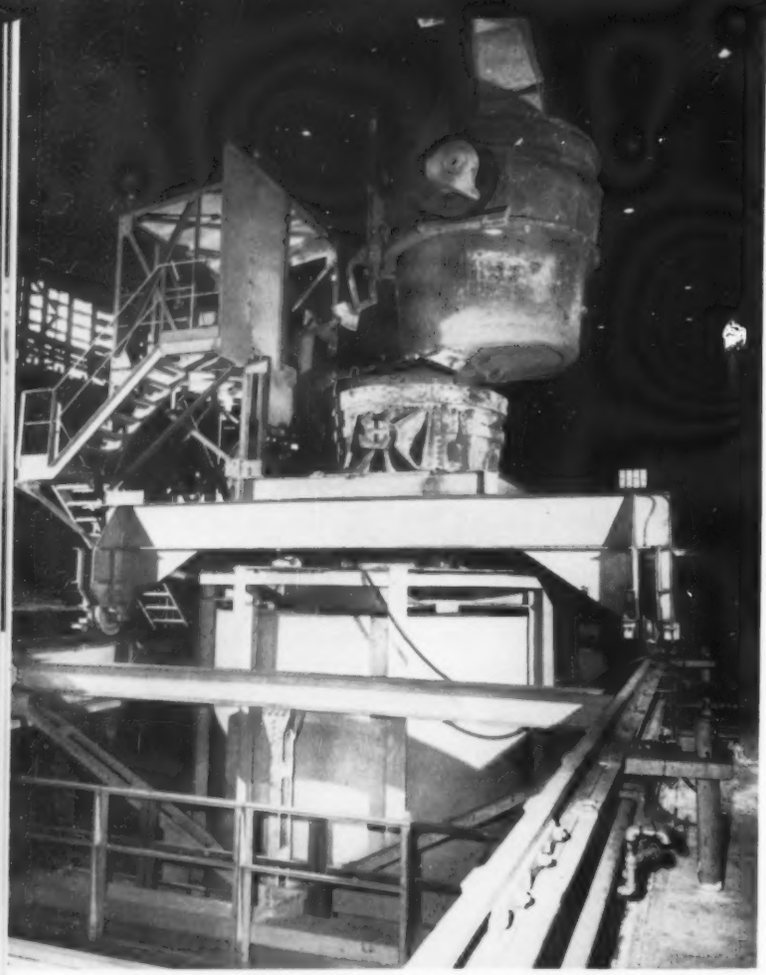


Figure 27 — At Duquesne Works the absolute pressure in the vacuum tank during casting is from 260 to 300 microns.

James M. Ford: I would like to know what the results might be if you got down to a high vacuum of 5 to 10 microns as far as ingot surface or center condition is concerned. Also, what type of hot top refractory are you now using? Have you gone to high-alumina brick yet?

Henry C. Bigge: In reference to high vacuums of 5 to 10 microns during vacuum degassing I want to point out that our vacuum degassing units were installed for a maximum pressure of 500 microns for the 7-ton vacuum degassing unit using five steam ejectors, and 1000 microns for the 250-ton vacuum degassing units using four steam ejectors.

We have given the ranges at which we operate the various vacuum degassing units when pouring metal into the vacuum degassing tanks. The condition of the ingot surface in our process depends upon the temperature of the metal entering the vacuum degassing tank, the capacity of the pony ladle, the size of the furnace ladle, the size of the nozzle in the pony ladle, the rate of metal poured per minute, and the composition of the metal.

The range of ingots varies from 62 to 120-in. diam, and each grade, diameter of ingot and total weight of ingot must be considered. The distance from the bottom of the pouring funnel to the top of the sinkhead is another factor which must be considered to obtain satisfactory ingot surface.

The vacuum pressure may vary from 300 to 1200 microns without any effect on the ingot surface.

In coreless vacuum melting and consumable electrode vacuum melting, a large percentage of gases is extracted as the melting progresses. Therefore, the same conditions do not exist as in vacuum degassing, and a better surface should be obtained. However, I have inspected some ingots made by consumable electrode vacuum melting which had very rough surfaces necessitating rough turning the ingots before further processing.

In reference to the use of special refractories in the hot top we have found that it is necessary to use special refractories of high alumina content and higher melting points than the ordinary refractories used when making air cast ingots. The spread of the molten stream entering the sinkhead has a tendency to cover the inner side of the sinkhead, causing erosion. In a floating sinkhead, special refractories are required for packing the space between the inside of the mold and the outside of the floating sinkhead to prevent any leakage of metal due to the vacuum and the temperature of the molten metal.

Michael Orehoski: On the pouring pit side of the electric furnace shop at United States Steel Corp. Duquesne Works, Figure 26, is a pit about 25 ft deep and 25 ft wide. A vacuum tank 15 ft in inner diameter and 28 ft high fits into the pit on the vacuum base. Grooved flanges and O-rings are used at the vacuum base and at the top of the tank to insure airtight joints. A conventional 30-ton tapping ladle modified to provide an airtight seal is placed on top of the tank. A flange welded to the bottom of the ladle supports the ladle, and a special device attached around the nozzle seals this area.

The 36-in. diam exhaust line is connected to the tank base. At the other end of the line is a 4-stage steam ejector that was designed to handle 100,000 cfm of a gas mixture having a mean molecular weight of 19.3 at an absolute pressure of 0.6 mm Hg. In the exhaust line between the tank and the ejectors is a large valve.

The distance between the bottom of the pit and the top of the ejector system is about 85 ft.

Figure 27 shows the vacuum casting operation. The larger ladle contains a heat of steel which is being poured into the pony or transfer ladle on top of the tank. The molten steel flows through the pony ladle and into the mold inside of the vacuum tank. The absolute pressure during casting of the ingot body ranges from 260 to about 800 microns. The gantry crane provides the pouring platforms for the operation but does not support the pony ladle.

Figure 28 — Frequency distribution of hydrogen content in steel before and after vacuum casting.

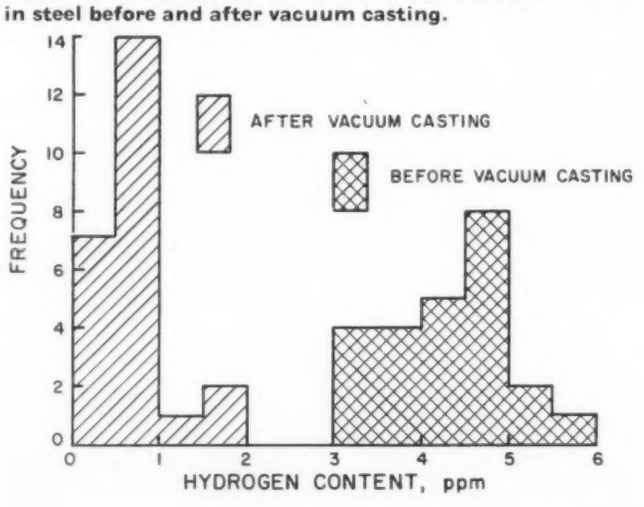


TABLE III

Hydrogen, Oxygen, and Nitrogen Contents of Heats Before and After Vacuum Casting

Gas	Remarks	No. of heats	Gas content, ppm	
			Range	Average
Hydrogen	Before vacuum casting	24	3.3 to 5.8	4.3
	After vacuum casting	24	0.3 to 2.0	0.8
Oxygen	Before vacuum casting	7	20 to 70	36.5
	After vacuum casting	7	10 to 60	26.5
Nitrogen	Before vacuum casting	9	30 to 200	80.0
	After vacuum casting	9	30 to 190	75.0

Data on hydrogen, nitrogen and oxygen were collected on some steels before and after vacuum casting. Figure 28 shows the frequency distribution of the hydrogen content in 24 heats of steel before and after vacuum casting. Only three heats showed hydrogen values greater than one ppm. These heats were not of rotor steel composition.

Table III shows that the hydrogen content of 24 heats ranged from 3.3 to 5.8 ppm before vacuum casting with an average of 4.3 ppm and from 0.3 to 2.0 ppm after vacuum casting with an average of 0.8 ppm. Only about 10 ppm of oxygen was removed from seven heats of vacuum cast steels. Since aluminum and other strong deoxidizers were not used in making the heats for these large forgings, the steels were deoxidized by the reaction of carbon and oxygen when they were exposed to reduced pressures. The removal of hydrogen and oxygen creates a boiling action of the metal during casting, much like that observed during the casting of undeoxidized steel. Vacuum casting does not appear to be very effective in removing nitrogen from the steel. The inability of the degassing process to remove nitrogen may be associated with the chemical composition of the steel. Some elements increase the solubility of nitrogen in steel or form stable nitrides with the result that very low casting pressures (below the decomposition pressure of the nitrides) are required to remove the nitrogen.

Figure 29 — This deep etched test of a 37-in. octagon section was water quenched after being forged. Note the absence of flakes.

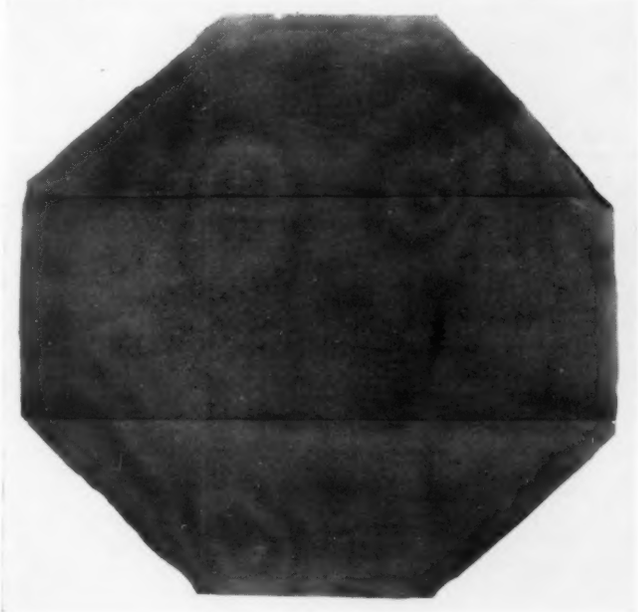


TABLE IV

Comparison of Tensile Ductility of Aged and Unaged Specimens of Air Cast and Vacuum Cast Ni-Mo-V Rotor Forgings

Remarks	Elongation, per cent		Reduction in area, per cent	
	Range	Average	Range	Average
Air cast				
Unaged	11.0–16.5	13.8	18.8–30.8	23.7
Aged	16.5–20.5	19.4	37.9–53.3	47.5
Vacuum cast				
Unaged	16.0–21.5	19.9	47.7–57.6	53.0
Aged	15.0–23.0	20.2	44.7–57.3	53.2

The vacuum cast ingots were tested for flake sensitivity after the forging operation. Discard sections, some of which were as large as 37-in. octagons by 8 to 10 ft long were air cooled and/or water quenched after forging. After a suitable time at room temperature for the incubation of internal defects, the sections were examined for flakes with an ultrasonic detector and by deep etched tests. Figure 29 shows a deep etched test of a 37-in. octagon section that was water quenched from the forging press. Note the absence of thermal flakes.

Prior to the vacuum casting operation, tension test specimens obtained from the rotor forgings were aged so as to meet the required tensile ductility. The term "aged" as used here means that the specimens were heated to 500 F and held for one hour to permit a rapid diffusion of hydrogen out of the steel. Table IV shows a comparison of tensile ductility of aged and unaged specimens of air-cast and vacuum-cast Ni-Mo-V rotor forgings. The data indicate that the aging treatment is essential for obtaining optimum tensile ductility in air cast steels but is not essential for obtaining this property in vacuum cast steels. Although the reason for the improvement in tensile ductility of vacuum cast steel as compared with aged air cast steel has not been ascertained, the improvement may reflect cleaner steel.

Summarizing, a practical method has been developed for the vacuum casting of commercial ingots ranging from 7 to 220 tons at less than 1000 microns abs. pressure. Although more data is required for a full evaluation of the method, the results to date indicate that the vacuum casting process:

1. Reduces the hydrogen in most of the steels studied to less than one ppm, although the amount of hydrogen retained depends on the grade of steel.
2. Reduces sensitivity to thermal flaking.
3. Improves tensile ductility of rotor forgings.
4. Deoxidizes some steels, the amount of oxygen removed being related to the composition of the steel.

In answer to Mr. Ford's question we have cast ingots in the pressure range of about 300 to 400 microns. We have not noticed much difference in hydrogen content in those steels to the heats cast at the high absolute pressures of 800 microns.

James M. Ford: I am speaking of ingot surface quality.

Michael Orehoski: We have not noticed any difference in surface quality. The first ingots that were vacuum cast had spongy surfaces, but this condition was subsequently corrected. ▲

Design Standardization of Coke Quenching Locomotive

by R. G. Zahner and R. K. Waldman

Locomotive and Car Equipment Dept., General Electric Co., Erie, Pa.

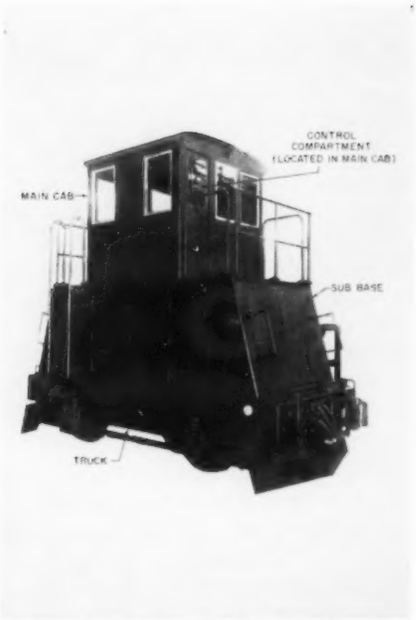


Figure 1 — Standardized design, 20-ton, 250-volt, d-c coke quenching locomotive.

UNTIL recently, the General Electric Co. built each coke quenching locomotive to suit individual customer's particular requirements—a slow and expensive process. To check ever-increasing costs and to provide the shortest possible shipment, a standard locomotive was needed that could be built in quantity. A simplified standard design was produced, based on experience from previous designs, and information from field studies.

DEVELOPMENT OF DESIGN

The first steps in the preparation of the standard design were: (1) to review and collate data on customer's requirements collected over a period of years and; (2) to make an engineering study of previous designs in order to accommodate as many general requirements as possible in the first proposal. A locomotive outline was then drawn up, illustrating the proposed equipment arrangement and mechanical construction.

This preliminary design was discussed with customers and valuable suggestions obtained. For example, the control compartment required rearrangement to improve accessibility from both the front and the back for maintenance. The control circuits needed changing to increase the motor torque on the two steps of "creep" used while the coke is being loaded into the quenching car. The operator's cab doors should be arranged to permit access to manual water quenching valves. Moreover, provision should be made to omit the cab end door near the car end, when customers object to this location. Most of these ideas were incorporated when the basic standard locomotive design was finalized.

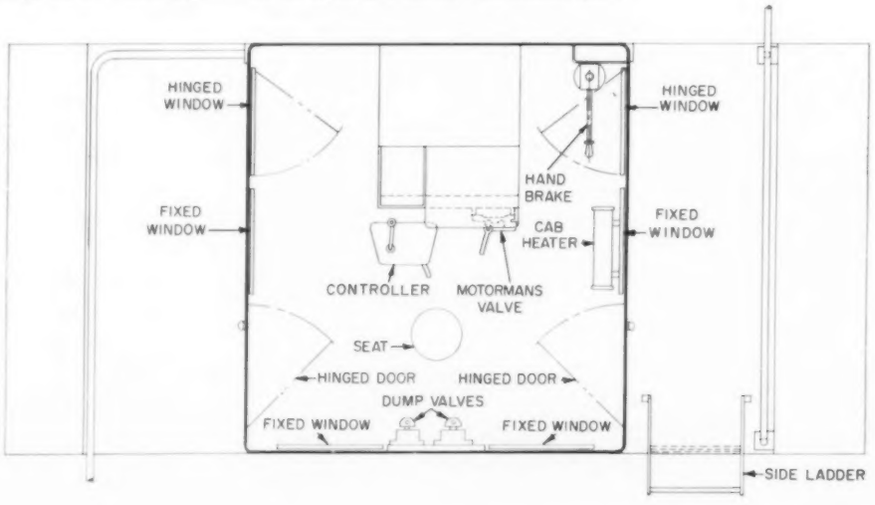
DESCRIPTION

For purposes of design and manufacture, the mechanical portions of the locomotive were grouped in four major subassemblies: (a) truck, (b) sub-base, (c) main cab, and (d) control compartment, as indicated in Figure 1.

A welded design truck consisting of rolled steel plate side frames and fabricated steel plate end frames is used. The locomotive weight is carried on helical springs nested in cutouts in the frame above the journal boxes. While the truck frame is designed for plain journal bearings, it can be easily modified for roller bearings. The usual sheet steel coke plow is mounted below each end frame. Sand boxes are located in the truck frame. This makes it possible for one man to fill them while standing on the ground, and also helps prevent water from getting into the sand boxes.

The sub-base is longer than the

Figure 2 — Arrangement of equipment in the main cab.



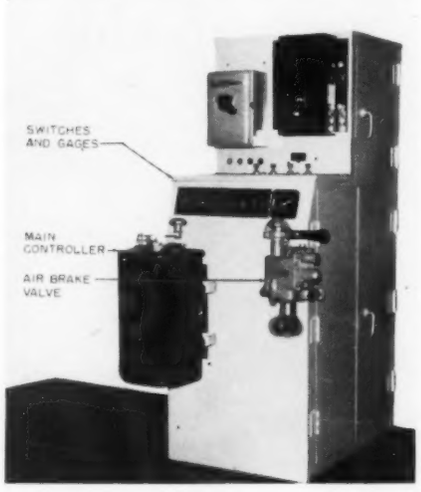
main cab, thus providing a walkway at each end of the locomotive. Provision is made so that auxiliary platforms, side platforms and handrails can easily be added to suit customers' requirements. Equipment in the sub-base includes the air compressor, air reservoir and accelerating resistor. Full width doors at each end of the sub-base and two doors in the side away from the oven give ready access for maintenance, and make removal of equipment easy. The traction motors can also be removed through the full width access doors.

The main cab, Figure 2, is designed as a shell with four door openings, giving a choice of three door arrangements. Standard locomotive design provides two doors, located to suit the customer. The remaining two door openings are filled with window panels. There are no windows in the side of the cab adjacent to the ovens, thus protecting the operator from the heat. Six windows, located on the other three sides, and two windows in the doors, provide the visibility required to properly spot and load the car. Cab window frames are stainless steel to resist the corrosive atmosphere, and heat-resistant glass is used throughout.

The main cab is lined with $\frac{3}{16}$-in. sprayed insulation, and the floor is covered with water-resistant marine plywood.

The new control compartment, Figure 3, is designed to be subassembled and wired prior to locating in the locomotive. Traction control equipment occupies the lower half of the structure, the upper half being reserved for electric dump control. A console type design provides both front and back access for easy maintenance of equipment. The compartment with the controller, air brake valve, switches and gages all mounted is installed as a unit.

Figure 3 — Console-type control compartment with locomotive controller and air brake valve is mounted on front face.



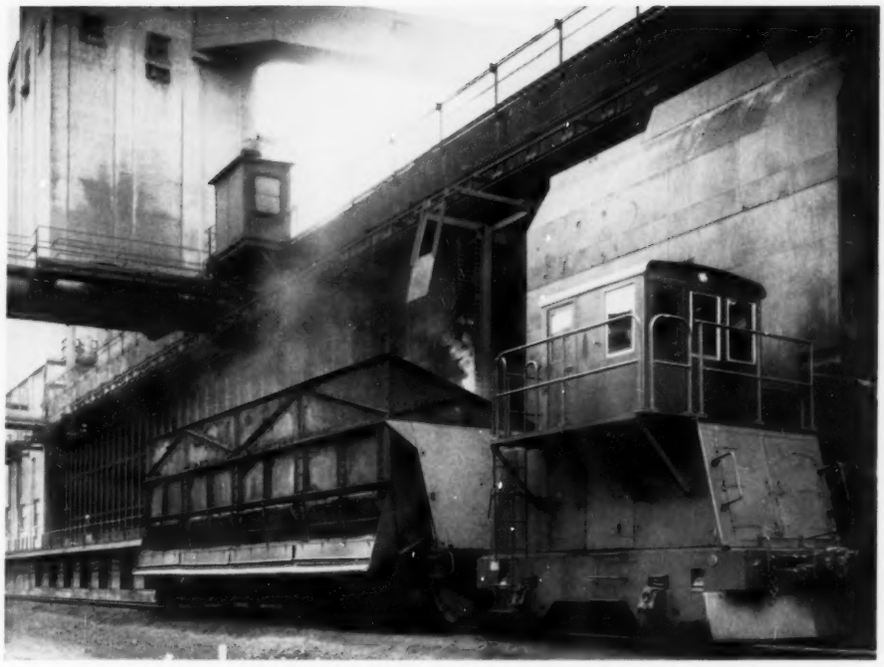


Figure 4 — Standardized design locomotive has given good service.

Two d-c, series-wound, enclosed box-frame type traction motors power the locomotive. The motor armature is carried in separate heads fitted with sealed-type roller bearings. Conventional spring suspension mounting and single-reduction spur gearing are used.

The locomotive is equipped with series-parallel progressive control providing 7 points series and 5 points parallel operation of the traction motors. A single master controller, mounted on the control compartment, is located as shown in Figure 2.

The locomotive is fitted with a straight air brake system. A motor-driven, 2-stage air compressor is located in the sub-base and is easily removable through either side or end access doors. Equipment also includes two 8 x 8 brake cylinders, and a reservoir of 22,500 cu in. capacity. Hoses at each end of the locomotive permit connection to the air brakes on the quenching car. A hand brake is provided for holding the locomotive at a standstill.

The necessary dump valves and hose connections are provided for use with an air-operated quenching car. Piping is run to each end frame so that hoses can be furnished at either end as requested. The two dump valves are located on the wall opposite the oven to facilitate operating the coke quencher with the quenching car at either end.

Equipment options available without changes in the basic design are: electric car dump control in place of air dump; indicating lights for air or electric dump; and window wipers.

SPECIAL FEATURES

Each coke quenching plant has conditions which require special features on the locomotive. These include the location of the third rail; the location of the coke oven bench; manual or automatic operation of the quenching valve; air or electric operation of the dump; and the arrangement of doors and walkways to suit particular requirements.

The standard design permits building the basic locomotive in quantity. These units will not have walkways other than those formed by the sub-base. The third-rail collector supports and the door and window panels will also be missing. This permits the customer to choose door and window arrangements and location of the auxiliary platforms and collector supports to meet his requirements. ▲

McLouth Steel Puts Self-Fluxing Sinter Line Into Operation

FACILITIES for the daily production of 2100 tons of self-fluxing sinter for blast furnace charging were recently placed in operation at the Trenton, Mich., Works of McLouth Steel Corp.

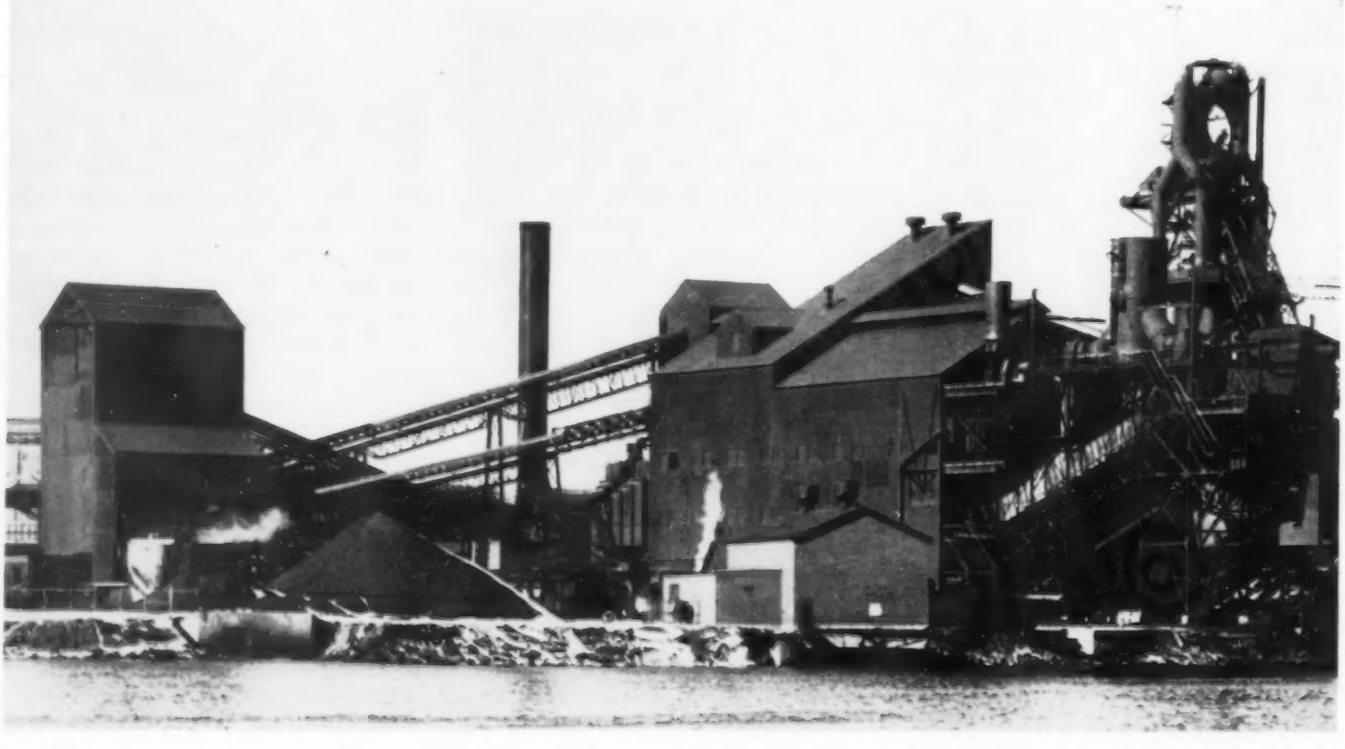
Engineered and built by Dravo Corp. of Pittsburgh, the plant went into full production only two weeks after the start of pilot operations. It produces sinter for use at McLouth Steel's two blast furnaces at Trenton.

Constructed by Dravo under a licensing agreement with the Lurgi Co. of Germany, the installation is the first Dravo-Lurgi plant in this country featuring a straight-line, induced draft cooler for the sinter product. Earlier Dravo placed a 2400-ton-per-day plant with a circular cooler in operation at the Ashland, Ky., Works of Armco Steel Corp.

At the present time, cold-run operations are being conducted by Dravo on sections of two 15,000 tons-per-day plants, also with circular coolers, for U. S. Steel Corp. The latter installations, rated as the largest in the world, are under construction at Saxonburg, Pa., and Gary, Ind.

With the completion of the four Dravo-Lurgi units, more than 11 million tons of sinter will be added

Figure 1 — Latest sinter plant to go into operation in this country is a 2100-ton-per-day installation at the Trenton, Mich., Works of McLouth Steel Corp.



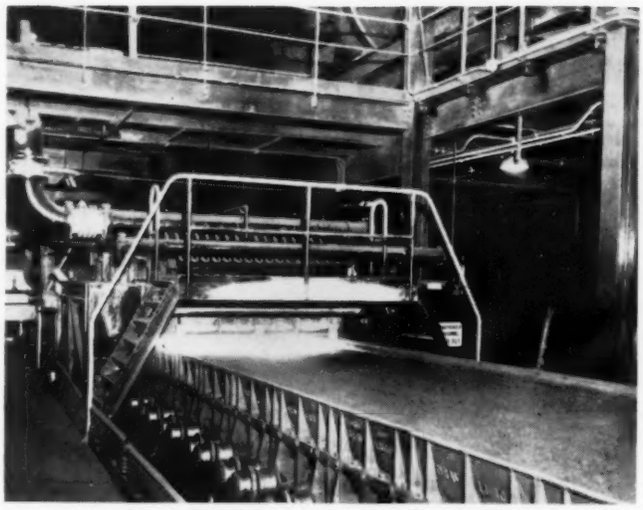


Figure 2 — Ore fines and flue dust, with limestone added as a flux, are agglomerated under intense heat on this 111-ft sinter strand. With coke breeze as a fuel, ignited in a special gas furnace in background, the fusing of materials is aided by 13 windboxes.

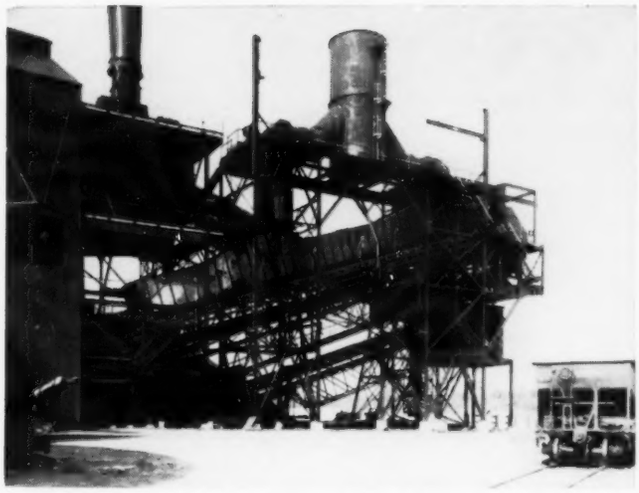


Figure 3 — The 137-ft long straight-line cooler at the Trenton Works of McLouth Steel Corp. is designed to reduce the temperature of the sintered material from 1450 to 235 F. It has a capacity of 2500 tons per hr.

to this country's annual output.

The McLouth sintering facility, built primarily to agglomerate Lake Superior ore fines too small to be charged directly into the blast furnaces, is also being used to reclaim a five-year accumulation of flue dust containing a high iron content. McLouth estimates this flue dust stockpile, once considered of little value, at approximately 300,000 tons.

Heart of the sinter plant is a continuous strand sinter machine consisting of 77 cast iron pallets. It measures 111½ ft overall with a length over its 13 windboxes of 84½ ft. With a width of 8¼ ft, it has a suction area of about 700 sq ft. Speed of the strand may be regulated from 6½ to 17 fpm.

The sinter machine is equipped with a hearth layer system, a roll feeder for the sinter mix, a gas-fired furnace with a rammed-type refractory lining, pallet tipping wheel, adjustable drive train, and a special sinter breaker.

The cooler, about 137 ft long, with a capacity of 2500 tons per hr, lowers the temperature of the sintered material from about 1450 F to approximately 235 F; a heat level at which the material may be carried by rubber belt conveyors without belt damage.

Supplying fines and miscellaneous materials—coke, flue dust, limestone and mill scale—to the sinter strand is an intricate system of hoppers, conveyor belts, vibrating feeders, table feeders, vibrating screens, plus such processing equipment as pug mills, rod mills, balling drums and sinter dust collectors.

A feature of the handling equipment is the installation of nine Dravo-Schenck vibrating screen or feeder units. Through mechanical "micro-thrust" vibration this equipment literally throws the material forward in a series of parabolic arcs so small that it appears to flow. Three units are used for feeding and screening hot sinter from the machine to the straight-line cooler; two other screens are used for primary and secondary grading of sinter product; and feeders are used on hot sinter fines, raw coke, and for handling sinter machine and cooler spillage.

Crude ore is brought from an adjacent storage yard by high line transfer car and dumped into three bins having a total capacity of 400 tons. From these bins, the material is fed to a conveyor belt which passes over a weigh scale enroute to a 60-ton ore surge hopper. Ore is fed from the hopper by a vibrating feeder to a vibrating screen with a ⅜-in. screen deck. Ore above the ⅜-in. size is directed to a high line storage bin for direct transfer to the blast furnaces or to an emergency storage yard. That passing through the screen as fines is carried by conveyor belt to storage bins for feeding to the sinter mix belt supplying the sinter machine.

Miscellaneous materials are discharged from railroad cars into track hoppers for transfer by belt to a surge bin from where they are fed to a 1-in. vibrating screen. Materials passing through the screen are conveyed by another belt system to their respective sinter plant feed bins. Material not passing through the one-in. screen is discharged to a rubble bin for disposal.

Coke breeze, after the one-in. screening, is deposited in a storage bin and fed out at a controlled rate to an air-blown rod mill of 25-tons-per-hr capacity. After being crushed to minus ⅛-in. size in the rod mill the coke is peripherally discharged into a 25-ton bin. From there it is transferred by skip hoist to an 85-ton ground coke storage bin feeding by conveyor to the sinter mix belt.

The raw materials for the sinter mix are control-fed to the belt by means of table feeders beneath the respective bins, with three trans-weigh scales in the belt system to aid the sinter machine operator in setting the composition and rate of feed. The first scale indicates the total weight of ore fines and cold sinter fines being fed to the mix.

The second scale is installed on the coke breeze conveyor feeding the sinter mix belt. This scale, calibrated to the first weigh scale, regulates the amount of coke added to the mix as determined by the fed weight of the ore and sinter fines. These two items constitute the largest proportion of material contained in the mix. When flue dust,

limestone, mill scale and filter cake are added, the amount of coke used will vary; again with its rate of flow adjusted and controlled by the calibration of the two scales.

The third scale indicates the total weight of the mix after water has been added in a pug mill. After pug mill treatment the material passes to a balling drum where still more water is added and where the material takes on the form of small balls of various sizes. These pellets, much like marbles, are then passed to a surge bin from where they are fed by roll feeder to the sinter strand. Speed of the feeder is electrically interlocked to the machine speed.

As a bed for the sinter mix, a hearth layer of already sintered material, larger than $\frac{3}{8}$ in. but smaller than $\frac{3}{4}$ in. in size, is placed on the grate bars to a depth ranging from 1 in. to $1\frac{1}{2}$ in.

The ignition furnace is a welded steel shell with a rammed type refractory lining. The furnace is fitted with a row of gas burners providing up to 120,000 Btu per hr per ton of sinter produced. Bottom of the unit is protected by an annular water-cooled jacket, with water-cooled adjustable gates to prevent leakage at the ends. Mounted on a structural steel carriage fitted with wheels running on rails parallel to the strand, the furnace is easily accessible for repair or replacement.

At the discharge end of the Dravo-Lurgi machine the material is fed to a sinter breaker designed to reduce the product to a size of minus six inches. Breaker arms, mounted on a six-sided shaft, force the sinter cake through grizzly bars spaced to produce the desired size.

At this point the hot sinter is fed by a Dravo-Schenck vibrating feeder to a vibrating screen. Material under $\frac{3}{8}$ in. in size passes through the screen to a conveyor which carries it back to the hot sinter fines storage bin for subsequent return to the sinter mix belt.

Hot sinter passing over the vibrating screen is transferred by another vibrating feeder to the straight line cooler, where it is deposited on a pan conveyor consisting of 69 trays, 9 ft wide.

The trays are mounted on a continuous chain stretching between drive and idler sprockets. Between sprockets the trays run on continuous rails. Each tray has a pair of cast iron wheels near the trailing edge, and at the leading edge is supported by the trailing edge of the tray ahead of it in the strand. Tray speeds are from $2\frac{1}{2}$ to 8 fpm.

The cooler is equipped with two 200,000-cfm fans, $2\frac{1}{4}$-in. suction pressure, driven by 150-hp motors. Of the axial flow type, the fans discharge into a common stack with ducts to the stack angled upward for efficient air flow.

Upon discharge from the cooler the sintered material is passed through a series of screens. Sinter over $\frac{3}{4}$ in. in size is conveyed to a storage bin for transfer to the blast furnace area. A portion of the sinter between $\frac{3}{8}$ in. and $\frac{3}{4}$ in. is used as a hearth layer, while the excess is combined with the plus $\frac{3}{4}$ in. for blast furnace changing. The material smaller than $\frac{3}{8}$ in. is discharged into the cold sinter fines bin for re-feeding to the sinter mix belt. ▲

in furnace lining...

Plicast Monolithic Castables

better 4 ways

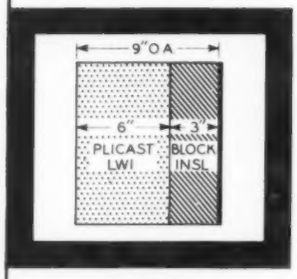
Study was made using special and ordinary linings in a car type annealing furnace operating at an inside temperature of 1800° F. Plicast LWI Insulating Castable and fire brick were compared to determine the hourly heat loss and heat storage capacity for each square foot of furnace wall.

1 **Heat loss 33% less . . . heat storage capacity 91% less with Plicast.** Outcome of the test illustrated to the right shows savings gained using lighter two-component wall poured with Plicast LWI Castable backed with block insulation.

2 **Cost of operating furnace much less with Plicast.** In this test $1,380 (14%) was saved in fifty weeks operating a car type furnace with a wall area of 300 square feet 8 hours daily, 5 days a week.

3 **Less material and maintenance needed with Plicast.** These results were obtained with one-third less refractory material in the walls and arch.

4 **Larger furnace capacity with Plicast.** The thinner walls added 6 inches in width, 3 inches in depth and height to the inside dimensions.



PLICAST
Heat storage: 3,650 btu/sq. ft.
3,650 btu=3.6 cu. ft. gas
or: .025 gal. oil

Heat loss: 180 btu/sq. ft.
(still air at 70° F.)
180 btu=.180 cu. ft. gas
or: .0012 gal. oil

FIRE BRICK
Heat storage: 42,000 btu/sq. ft.
42,000 btu=42 cu. ft. gas
or: .29 gal. oil

Heat loss: 270 btu/sq. ft.
(still air at 70° F.)
270 btu=0.263 cu. ft. gas
or: .0019 gal. oil

Write for Case Study Report giving complete data on 4-way savings or call your local Plibrico man to see how much you can save on your refractory lining.

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920P

TENTATIVE PROGRAM

AISE Western Meeting

HOTEL UTAH,
SALT LAKE CITY, UTAH

June 15, 16, 17, 1959

MONDAY, JUNE 15, 1959

8:30 am—REGISTRATION—
Mezzanine Floor

9:00 am—TECHNICAL SESSION—
Lafayette Ballroom

Chairmen: R. L. Dowell, Assistant to General Superintendent, Columbia-Geneva Steel Div., United States Steel Corp., Pittsburg, Calif.

Walter Lee Murphy, Assistant General Manager, Bethlehem Pacific Coast Steel Corp., South San Francisco, Calif.

"Modern Electrolytic Tinning Line Electrical Drive Systems," by J. E. Kraske, Steel Mill Application Engineer, Metal Working Section, Industry Engineering Dept., Westinghouse Electric Corp., East Pittsburgh, Pa.

"Maintenance of Mill Oil Bearings," by C. A. Bailey, Lubrication Engineer, National Tube Div., United States Steel Corp., Pittsburgh, Pa., and A. C. Cooper, Superintendent of Roll and Tool Shops, Lorain Works, National Tube Div., United States Steel Corp., Lorain, Ohio

"Modern Regenerative Soaking Pits," by Henry S. Hall, Assistant Manager, Combustion Control Dept., Morgan Construction Co., Worcester, Mass.

2:00 pm—TECHNICAL SESSION—
Lafayette Ballroom

Chairmen: W. H. Kinney, Assistant to Vice President of Operations, Kaiser Steel Corp., Oakland, Calif.

W. Truxton Purvance, Project Analysis Engineer, United States Steel Corp., Pittsburgh, Pa.

"Improved Hearth Life of the Blast Furnaces at Colorado Fuel and Iron Corp.," by John W. Carlson, Superintendent, Blast Furnace Dept., The Colorado Fuel and Iron Corp., Pueblo, Colo.

"The History and Performance of the HyL Sponge Iron Process," by Ing. Juan Celada, Chief Engineer, Hojalata y Lamina, S.A. Monterrey, Mexico, C. K. Mader, Project Manager, and R. Lawrence, Jr., Sales Manager, Metallurgical & Process Industries, The M. W. Kellogg Co., New York, N. Y.

"Trouble Spots in Sintering Plants," by Gordon R. Baer, Manager, American Ore Reclamation Section, Freyn Dept., Engineering and Construction Div., Koppers Co., Inc., Pittsburgh, Pa.

5:30 pm—BARBECUE

Buses will leave Hotel Utah at 5:30 pm for special canyon barbecue.

TUESDAY, JUNE 16, 1959

9:00 am—TECHNICAL SESSION—
Lafayette Ballroom

Chairmen: William Brill, Director of Engineering, The Colorado Fuel and Iron Corp., Pueblo, Colo.

W. E. Harris, Assistant Plant Superintendent, Consolidated Western Steel Div., United States Steel Corp., Los Angeles, Calif.

"Cost Estimating—Metal Working Plants," by A. J. Mosso, Executive Vice President, Auburn & Associates, Inc., Pittsburgh, Pa.

"Reclamation of Waste Waters at Geneva Works," by Earl H. Peirce, Combustion Engineer, and Ralph D. Hancock, Assistant Power & Fuel Engineer, Power & Fuel Engineering, Engineering Div., Geneva Works, Columbia-Geneva Steel Div., United States Steel Corp., Provo, Utah

"Modernization of the Seattle Plant," by N. L. Bock, Chief Engineer, and Kenneth Grant, Electric Furnace Superintendent, Seattle Plant, Bethlehem Pacific Coast Steel Corp., Seattle, Wash.

2:00 pm—TECHNICAL SESSION—
Lafayette Ballroom

Chairmen: Frank F. Argust, Superintendent, Industrial Engineering, The Colorado Fuel and Iron Corp., Pueblo, Colo.

T. G. Simison, Assistant General Superintendent, Rolling Mills, Kaiser Steel Corp., Fontana, Calif.

"Automatic Hot Strip Thickness Control—Geneva Works," by Louis E. Ringger, Assistant Works Engineer, and George S. Koss, Assistant Division Superintendent, Rolling Mills, Geneva Works, Columbia-Geneva Steel Div., United States Steel Corp., Provo, Utah

"Hot Strip Finishing Mill with Automatic Gage Control—Process System Analysis and Design," by Hugh S. Maxwell, Application Engineer, Metal Rolling & Processing Engineering, Industrial Engineering Section, and R. A. Phillips, Control Systems, Analytical Engineering Section, General Electric Co., Schenectady, N. Y.

"Quality Control at Pittsburg Works Particularly Related to Flat Rolled Products," by G. A. Jedenoff, General Superintendent, Pittsburg Works, Columbia-Geneva Steel Div., United States Steel Corp., Pittsburg, Calif.

7:00 pm—INFORMAL STAG DINNER—
Lafayette Ballroom

Welcome by the Honorable George D. Clyde, Governor, State of Utah

Speaker: L. B. Worthington, President, Columbia-Geneva Steel Div., United States Steel Corp., San Francisco, Calif.

WEDNESDAY, JUNE 17, 1959

8:30 am—INSPECTION TRIP—

Inspection Trip to Geneva Works, Columbia-Geneva Steel Div., United States Steel Corp., Provo, Utah. Buses will leave from Hotel Utah.

hotel reservations

Because of a Latter Day Saints church conference, which ends Sunday, June 14, arrivals in Salt Lake City should not be timed before that day.

Write direct for hotel reservations to Hotel Utah, Salt Lake City, Utah, giving time of arrival and type of accommodations desired. Reservations should state that they are for the AISE Western Meeting.

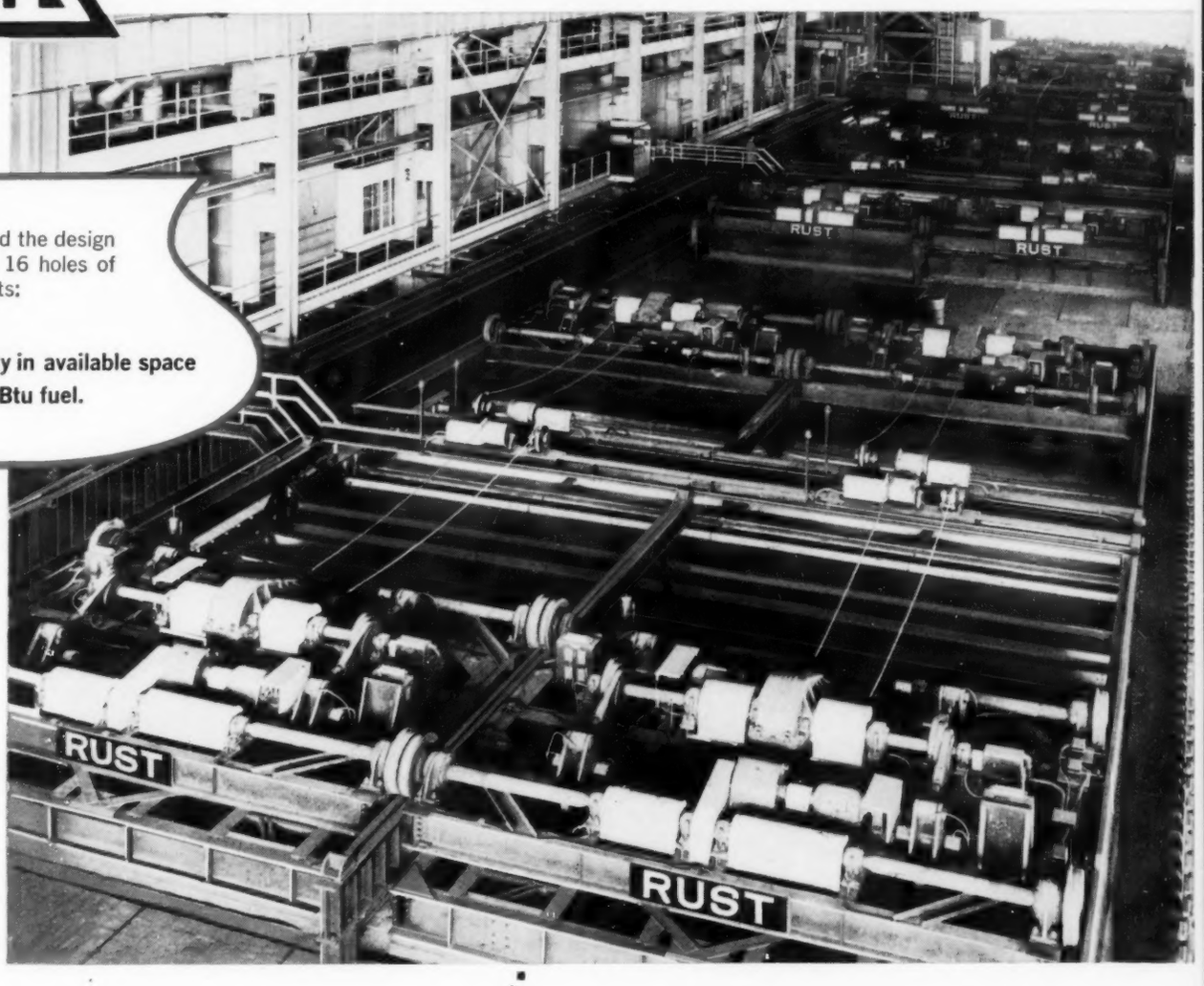
transportation

Individuals or groups desiring assistance in planning their trip should get in touch with the office of American Express Co. in their respective cities, or with any local travel agency.

Snow capped peaks form a picturesque backdrop for Geneva Works

soaking pits

accelerate ingot capacity ... even with low Btu fuel



Three requisites dictated the design requirements of these 16 holes of regenerative soaking pits:

1. **Quality heating**
2. **Maximum capacity in available space**
3. **Utilization of low Btu fuel.**

Island type layout employing eight batteries of two holes each was used for this specially designed installation at a large eastern steel mill. Pit size: 16′ wide, 20′ long, 10′5″ deep. Each hole has individual cover mechanism.

Completely modern temperature and combustion controls insure rapid, efficient heating with a high degree of uniformity from top to bottom and complete absence of washing.

Pits are cross-fired and each pit has primary checkers at the base of the downtakes and also secondary checkers at the base of ejector type stacks. The checker system preheats combustion air to approximately 2000°F. Each pit has two induced draft stacks equipped with automatic reversal systems enabling each hole to handle 35,000,000 Btu per hr. input of 106 Btu per cu. ft. mixed coke oven and blast furnace gas. Fuel rate for heating 3½ hr. track time steel is approximately 500,000 Btu per ton and 1,100,000 Btu per ton when heating cold steel.

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One contract covers everything from original idea through furnace start-up. One responsibility for design, manufacture, erection and initial operation. One overhead and profit (with substantial savings to you) on all phases of the work, including wiring and piping.

For either new or modernization projects – soaking pits or other metallurgical furnaces – consult us about your requirements.

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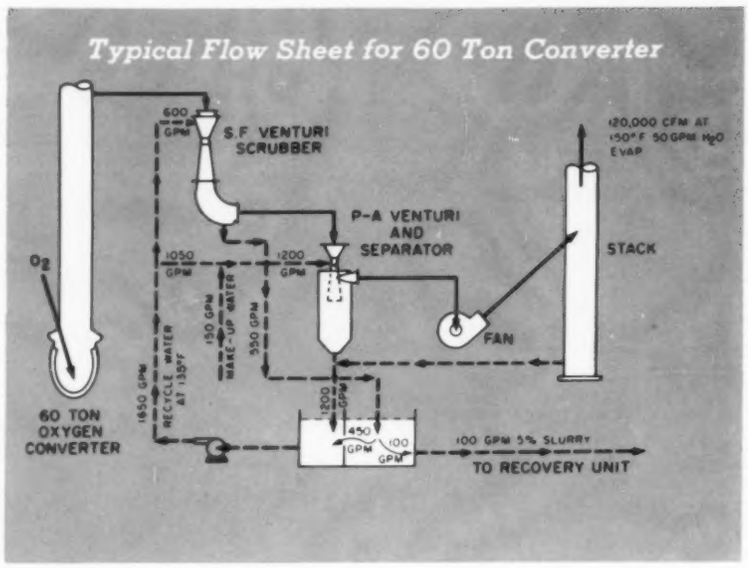

"virtually no maintenance since start-up on CHEMICO VENTURI WASHERS"

Where major investments are concerned, performance is vital. At the Algoma Steel Company's new Sault Ste. Marie Basic Oxygen Steel plant, Chemico Venturi washers are exceeding all original performance specifications. Case in point: since start-up in November, 1958, there has been virtually no maintenance on the Chemico washers. This is a normal record for Chemico washers. They are designed to eliminate shut downs for maintenance on gas washing systems, thus making it unnecessary to invest in spare equipment.

Chemico Venturis are paying Algoma other dividends, too, for these washers are operating at better than 98% efficiency. During test periods when operating at 50% over design capacity, the flexibility of the Chemico washers permitted the extra load to be handled without increased washing facilities.

If steel is your business and air pollution your problem, it pays to consider Chemico Venturi washers. You can obtain full information, a copy of a detailed technical brochure, and technical assistance concerning your problem by writing Chemico today.

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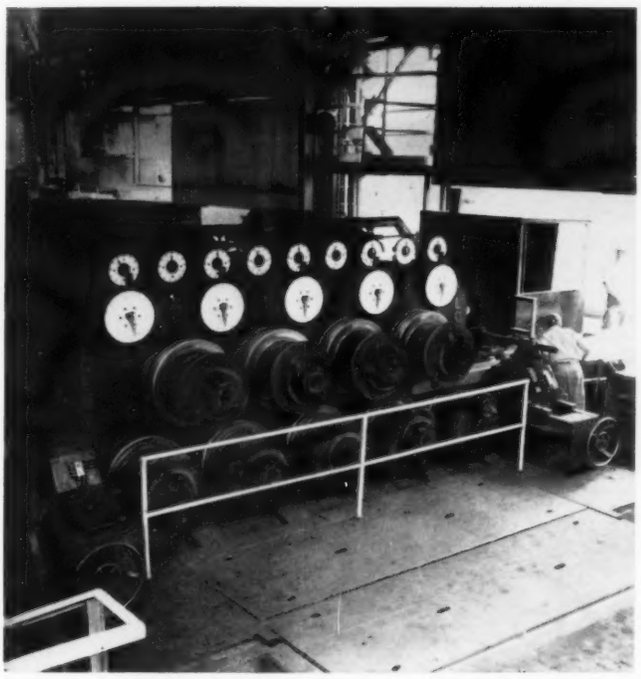


Figure 1 — One pass through the roller-straightener is all that is required to straighten I-beam or other structural members. A beam about to leave the straightener is shown in this view of the roller-straightener in action. Large dials above straightener indicate vertical and horizontal adjustment of rollers.

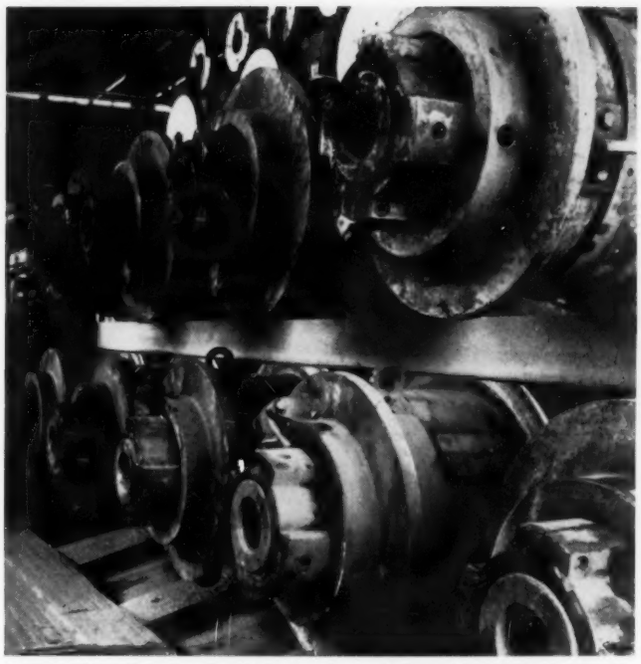


Figure 2 — Two operations are performed on a beam as it passes through the roller-straightener. Nine adjustable rollers (shown in this closeup) first bend the beam into a uniform curve, then aline it both horizontally and vertically into a straight beam. Two rolling surfaces on each roller make contact inside the beam to perform these bending operations.

I-Beam Straightener Has Advanced Features

A NEW type beam straightener—a roller straightener designed and developed by Loewy-Hydropress Division, New York City, of Baldwin - Lima - Hamilton Corp.—has revolutionized beam straightening at a large Eastern Pennsylvania steel mill.

Put into operation in August, 1955, the Loewy roller-straightener has since paid for itself several times over in terms of increased tonnage and decreased manpower requirements.

Replacing four gag press straighteners, each of which required a crew of four or five men, the roller-straightener has greatly increased the beam rolling mill capacity and raised the total weekly mill output tonnage.

Although gag presses do the job, they have certain drawbacks. For instance, the process depends to a large degree on the skill and judgment of the operator and six to seven years are required to develop really top-notch operators. Besides the operator, a crew of three or four men is required to move the beams to and from the straightener and inspect, identify and apply beams to orders or stock.

The biggest drawback of the gag press, however, is limited capacity. With all the manipulations involved, one gag straightener can handle only a certain amount of work in a given time. To increase the output necessitates not only greater investment in gag presses and crews but much more floor space and beam handling facilities.

The Loewy roller-straightener, with its large output capacity in a small space and its virtually automatic operation makes the gag press method rudimentary by comparison. The operator of the roller-straightener feeds the beams into the machine and adjusts the speed with which they pass through and are straightened—all by remote control. This operator can be trained in a matter of months and need not develop any outstanding skills or abilities.

The roller - straightener will straighten any length beam provided there are facilities available for moving the beam to and from the straightener.

Beams are initially produced by rolling ingots of red-hot steel back and forth between rollers, elongating the hot steel and forming it into the cross section of a beam. After being rolled, the beams are allowed to cool.

(Occasional beams in this mill, incidentally, are check-weighed immediately after rolling by another B-L-H development—a B-L-H SR-4 electronic weighing system located beneath the hot bed on which the beams cool.)

Because beams are formed while hot, they do not always emerge perfectly true. Often they are twisted or warped, or both. Once they have cooled to 250 F, or less, they must be mechanically straightened into final shape.

The old gag press method and the new roller-straightener method use two completely different approaches to the job of straightening beams.

The gag straightener consists of two vertical heads on which anvils are supported. The heads can be moved back and forth on slides and are tied together with four large screws. One head oscillates on a crank action, while the other is adjusted in and out by the person operating the straightener.

These heads straighten the beam by applying pressure to the bowed portions of the beam and are located completely by sight, with the operator's judgment determining the force applied.

With the many factors involved, even the most skilled operator does not always produce the most satisfactory results.

The principle of the roller-straightener, on the other hand, is quite simple.

The straightener consists mainly of nine rollers placed in two rows—four on top and five on bottom—between which the beams to be straightened are passed. Entry of the beams between these rolls is aided by a pair of vertical pinch rolls.

As the beam passes between the first upper roll and the first two lower rolls it acquires a new curvature of nearly constant and uniform magnitude. This curvature is then completely removed by gradually diminishing bends imparted to the beam while passing between the rest of the rolls.

Simultaneously with straightening of the beam horizontally, the beam is also straightened sideways (removal of "camber"). This is accomplished by roll "stagger"—lateral adjustment of the rolls—and a pair of vertical rolls at the exit end of the machine.

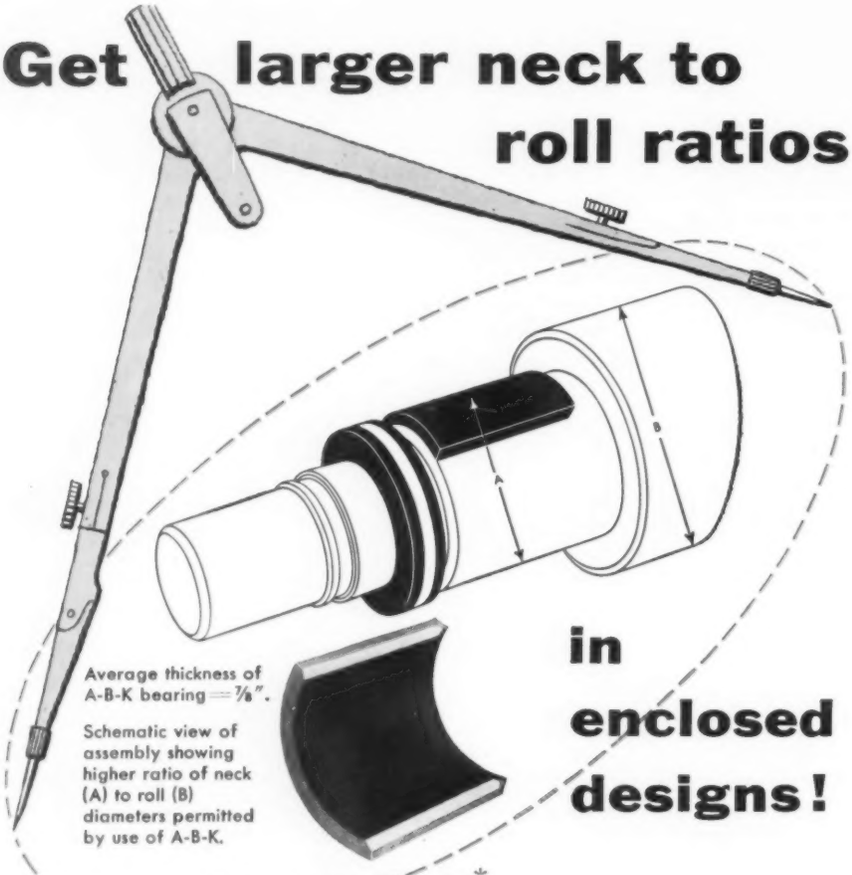
The Loewy straightener is quite flexible.

Beams any height from 4 to 21 in.—ranging in weight from 8.5 to 68 lb per ft—can be run through the roller-straightener. Completely straightened in one pass, beams move through the machine as fast as 600 fpm. Although any length beam could be straightened, hot bed capacity of this particular mill limits beams to 70-ft lengths.

In the three years following installation, the roller-straightener has been in service around the clock—20 eight-hour shifts per week—with no attention other than routine inspection and lubrication.

The Loewy roller-straightener was first introduced in 1951 after many years of research into possible methods for beam straightening. With five installations operating in the United States and Canada and others abroad, the roller-straightener is regarded throughout the steel industry as an important development in beam straightener design. ▲

Get larger neck to roll ratios in enclosed designs!



Average thickness of A-B-K bearing = 7/8".

Schematic view of assembly showing higher ratio of neck (A) to roll (B) diameters permitted by use of A-B-K.

use A-B-K* bearings

No need to sacrifice roll neck diameters to keep down size and cost of bearing assemblies and housings. A-B-K bearings save space, permit larger, stronger roll necks—with cheaper, lighter weight parts. A-B-K laminated phenolic bearings have ability to absorb and cushion heavier impacts, and often outwear metal, many times. Grease and oil can be used for lubrication but water, alone, is often the answer. Ask our engineers for specific recommendations.

- Wear longer
- Won't score or heat check
- Light in weight
- Cut lubricant costs
- Save power

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LAMINATED
PHENOLIC BEARINGS

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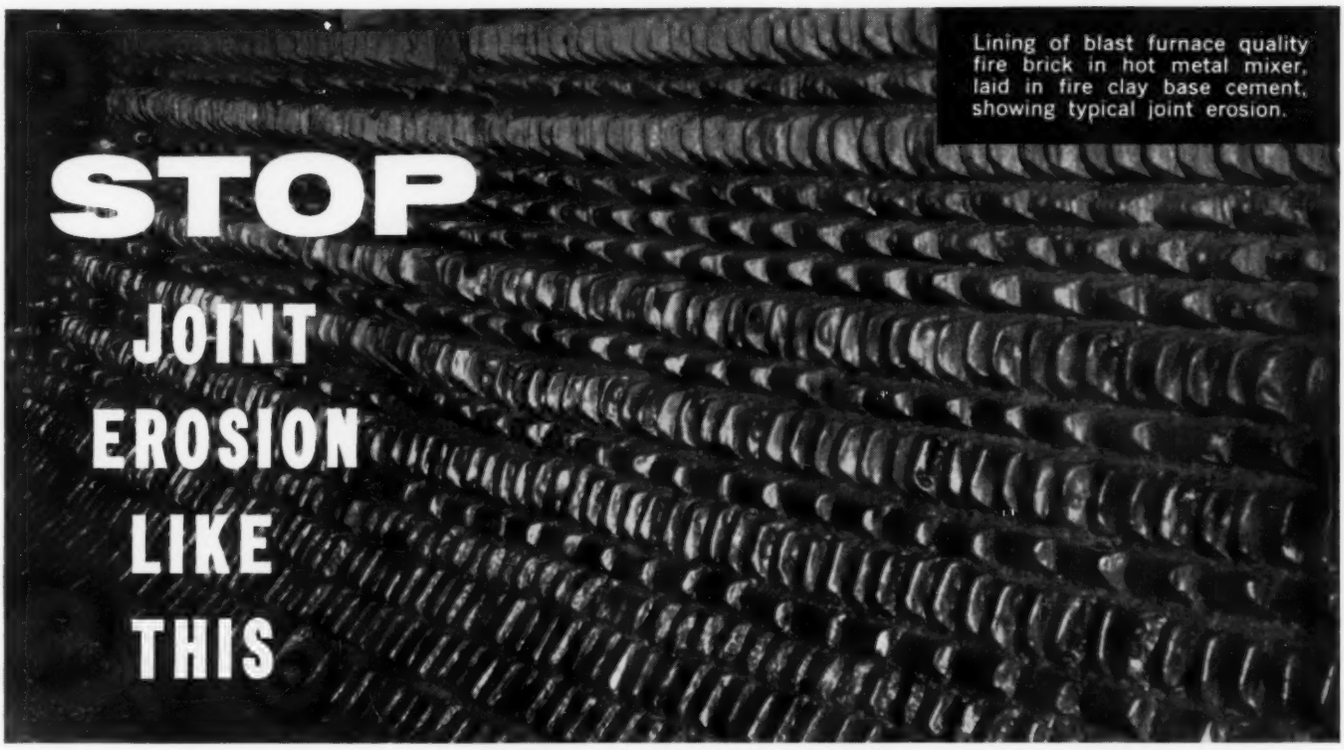

Lining of blast furnace quality fire brick in hot metal mixer, laid in fire clay base cement, showing typical joint erosion.

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Super-Refractory Cements

Experience has shown that the failure of refractory linings in most types of industrial furnaces usually begins at the joints in the brick work. TASIL (Taylor Sillimanite) Super-Refractory Cements are outstanding for high refractoriness, negligible shrinkage at high temperatures, and resistance to slagging and abrasion. Thus the tight, weld-like joints formed by TASIL Cements prevent joint erosion and rapid failure of the furnace lining.

TASIL Cements are recommended for bonding sillimanite or mullite, high-alumina, kaolin-type and super-duty fire brick and special shapes in any high-temperature furnace. They are especially recommended for bonding linings in:

Hot Metal Cars and Mixers
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Electric Furnace Roofs and Sidewalls when built of Alumina-Silica Brick
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Also excellent as a protective coating on walls and arches built of insulating fire brick

Let the Taylor field engineer in your district give you full details, or write for your copy of TASIL Cements Bulletin No. 314.

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Architect: GRAHAM, ANDERSON, PROBST & WHITE, Chicago, Illinois
Electrical Contractor: HYRE ELECTRIC CO., Chicago, Illinois

Electrical Protection goes MODERN *with BUSS fuses! . . . in the MORTON SALT BUILDING Chicago, Ill.*

The beautiful, new Morton Salt Building is located at 110 North Wacker Drive in Chicago — just outside the Loop.

The safest and most dependable electrical protection was needed because the engineers estimated the available fault current might easily reach a value of 75,000 amperes.

For this reason, the main switchgear, consisting of 1-4000 ampere, 1-2000 ampere and 1-1200 ampere pressure switch, is completely equipped with BUSS Hi-Cap fuses.

To make available the same safe, dependable and trouble-free protection, all distribution panels are equipped with FUSETRON dual-element fuses.

THERE IS A BUSS OR FUSETRON FUSE FOR EVERY ELECTRICAL NEED

Morton Salt Building: Mains and Feeders protected by BUSS Hi-Cap and FUSETRON Fuses

ONLY FUSES OFFER THE SAFETY AND DEPENDABILITY REQUIRED FOR TODAY'S CIRCUITS

Because of the ever-increasing transformer and network capacities, Power Companies now consider quite possible fault currents of 75,000 to 200,000 ampere.

So too, the requirements for protective devices have been changed to assure safe interruption of these higher fault currents.

Fuses, — because of their high interrupting capacity and dependability — prove superior in meeting modern protection requirements.

With Fuses, Safe Protection Remains Safe

Dust, fumes, corrosion or age cannot increase a fuse's capacity or lengthen its blowing time. The operation of a fuse is not dependent on latches, triggers or other devices that are subject to the strains and jars of mechanical action — both in opening and closing.

A fuse cannot stick or fail to operate when electrical trouble occurs. 1 year, 5 years or 20 years from now, a fuse will provide the same, high degree of protection as on the day it was installed.

On installations of 0 to 600 amperes . . .

By Installing FUSETRON dual-element FUSES — YOU GET 10 POINT PROTECTION

With rare exceptions, other types of protective devices protect only against short-circuits —

BUT, FUSETRON dual-element fuses give you safe, trouble-free 10 point protection.

For the FUSETRON fuse story ask for Bulletin FIS.

For Loads above 600 amperes . . .

BUSS Hi-Cap Fuses offer Safest, Most Modern Protection

They have an interrupting capacity sufficient to handle any fault current regardless of system growth — and by coordinating them with FUSETRON fuses on feeder and branch circuits, outages caused by fault currents can be limited to circuit of origin.

For the BUSS Hi-Cap fuse story ask for Bulletin HCS.

359

BUSSMANN MFG. DIV. McGRAW-EDISON CO. ST. LOUIS 7, MO.

Rod Mill Rolls Formed By Grinding

A GRINDING method to form and redress passes in rod mill rolls has been developed by the Sheffield Corp. The new method is an extension of Sheffield's "Crushtrue" wheel forming and dressing process which has been used successfully for precision thread and form grinding since 1940.

With this process, multiple grooves and forms can be ground simultaneously in a single operation. The grinding wheel is dressed to the desired contour by a hardened steel or carbide "Crushtrue" roll having the same profile as desired on the work piece.

At a recent demonstration, a new rod mill finishing roll of 11-in. diameter and 20½-in. barrel length was mounted between centers and steady rests on a "Crushtrue" multi-form grinding machine. The roll hardness was 84–86 Shore, considerably above the usual roll.

The grinding wheel was 20 in. in diameter x 4⅞-in. face, of 60-grit, J-hardness aluminum oxide. It was profiled to grind eight passes on ⅝-in. centers for finishing No. 5 rod. Each pass was 0.217 in. wide x 0.075 in. deep with an 0.116 in. radius at the bottom. Tolerances were held quite close, as indicated in Figure 2. The grinding wheel was driven at 1300-rpm or 7800-fpm surface speed. An oil mixture of sulphur base was circulated at 75 to 90-gpm for cooling. The feed was 0.008 in. per min at the start and was reduced to 0.004 in. toward the end of the cut. The roll was rotated at 34 rpm, or about 180 fpm surface speed.

Approximately 14 min were required per plunge, forming eight passes on the new roll. Four plunges completed the 30 passes on the roll body, requiring about 70 min for grinding and indexing. Redressing a used roll takes only about 40 min.

The profile of the grinding wheel retains sufficient accuracy for about 20 plunges. It is then redressed by an automatic "Crushtrue" device mounted on the grinding machine directly above the grinding wheel. This device automatically feeds the crusher roll (previously mentioned) into the wheel under considerable pressure. During this process, the wheel is driven at a surface speed of 250 to 300 fpm and drives the idling crusher roll by friction. Dressing (or recrushing) requires only about 30 sec and removes about 0.008 in. from the diameter of the grinding wheel.

Figure 1 — New method of forming rolls is an extension of the wheel forming and dressing process used for precision thread and form grinding.

The crusher wheel in this case was of carbide, 4⅞ in. in diameter x 4⅞ in. long. It is estimated that this unit should be reground about once a year.

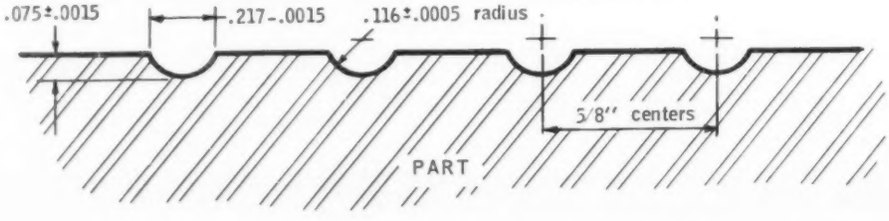
A separate crusher roll and grinding wheel is required for each pass pattern to be formed. These parts can be changed on the machine in about 30 min.

At present, grooves up to about ½ in. deep may be put into rolls by this method, and this may be increased in the future. This would make the process applicable pretty far back into rod and small bar mills.

While the grinding process is faster than the conventional turning method, the principal advantage will come from the use of harder mill rolls. The 84–86 Shore rolls (almost impossible to turn) ground in this demonstration will certainly outlast the 72–74 Shore rolls commonly used in the mills. In fact, ground passes in the softer rolls are said by one user to give about 15 per cent more tonnage than conventionally turned rolls. This may be due to the higher finish of the ground passes.

If satisfactory rolls of close to 90 Shore hardness can be obtained and formed by grinding, tonnage may well be doubled. This would mean a considerable reduction in mill outage for guide resetting. ▲

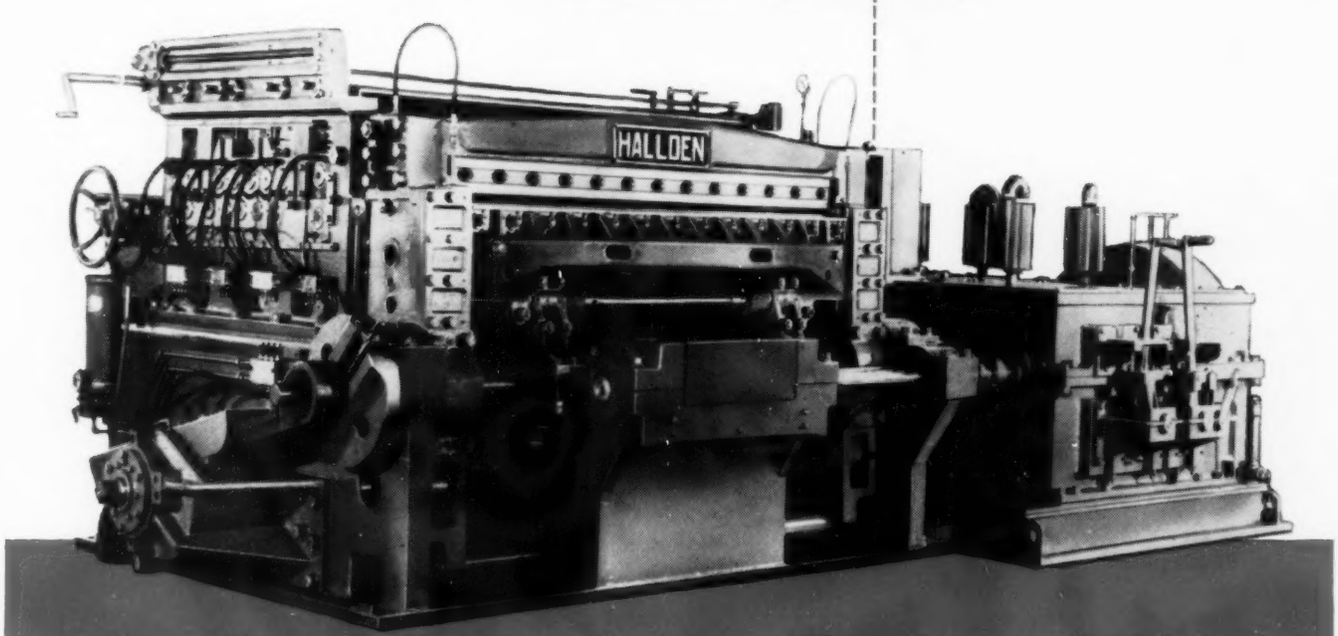
Figure 2 — Tolerances on grinding wheels are held quite close.



Stamco

announces

the addition of HALLDEN equipment to their complete line of steel mill equipment. Hallden and Stamco, teamed together...available from one source for complete integrated planning.



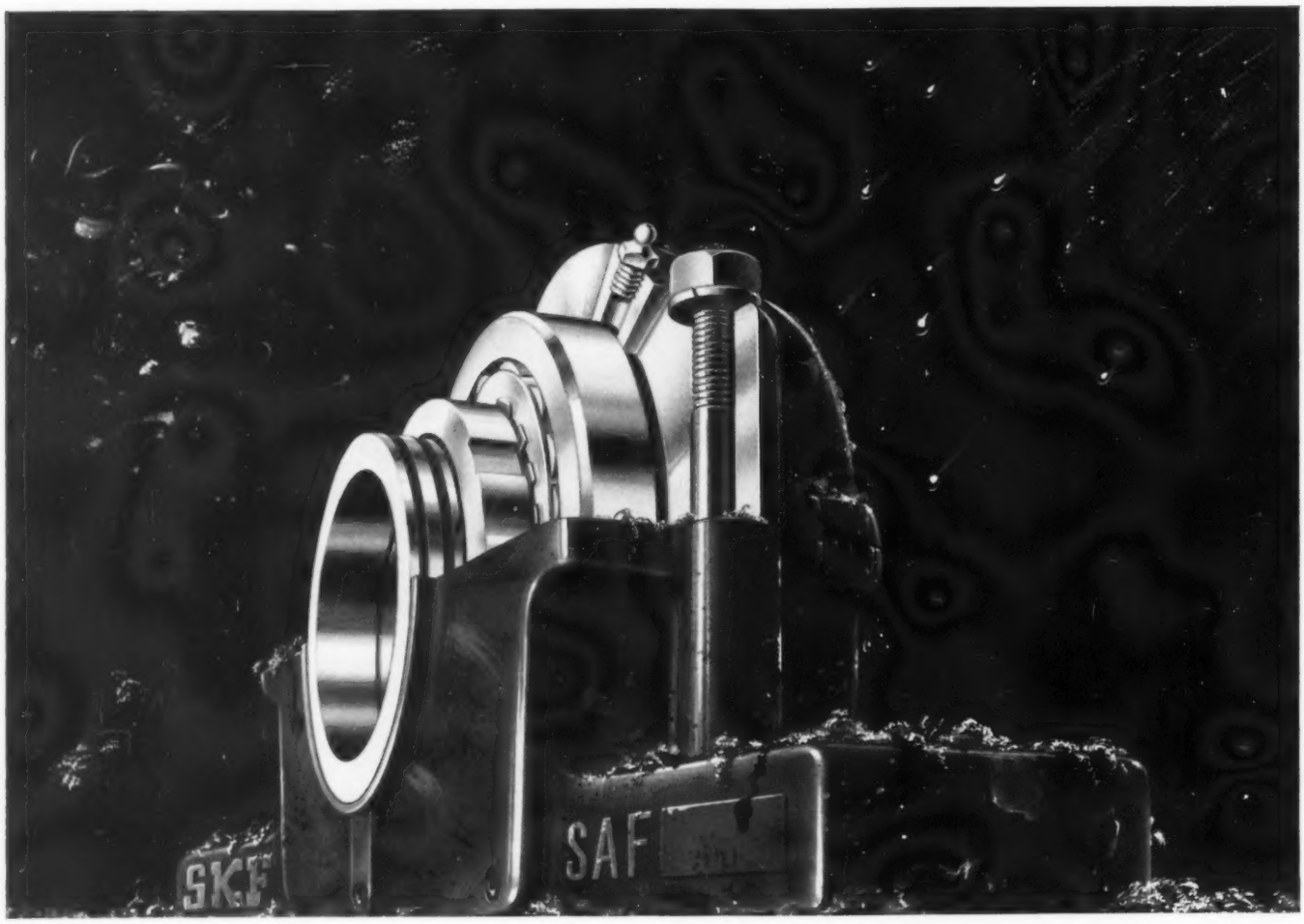
Type 541 Hallden Automatic Flattening and Cutting Machine

Stamco, Inc.

NEW BREMEN, OHIO, U.S.A.

ADVANCED ENGINEERING • SUPERIOR CRAFTSMANSHIP

Slitting and Coiling Lines • Cut-To-Length Lines • Flying Shear Lines • Power Squaring Shears • Automatic Resquaring • Corrugating • Culvert • Steel Mill Equipment



SKF Triple Seal
provides best possible protection

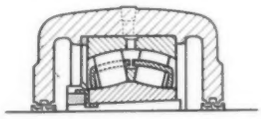
The SKF Triple Seal is a heavy duty, general purpose seal designed for use with oil or grease lubrication. It was developed by SKF to protect the bearing from foreign materials while providing an effective barrier against lubricant leakage.

The bearings in all SKF split pillow blocks are protected by triple seal rotating rings. The seals are triple lipped and are one integral unit. They are mounted with a slip fit on the shaft which permits unrestricted axial motion. Being of the labyrinth type, there is no friction between the rotating and stationary components; consequently, there is no wear and no replacement problem.

SKF Triple Seal Type SAF pillow blocks, with ball or roller bearings, give long trouble-free service. If your design involves abnormal operating conditions, cast steel housings (designated SAFS and SDAFS) are available. These heavy-duty pillow blocks are recommended for use in oil field machinery, steel and rubber mills, crushers, etc.

Standard type SAF split pillow blocks are available for ¾" to 10½" dia. shafts, and Type SDAF for 2 11/16" to 14" in adapter type mounting. Direct shaft mounting available for shaft shoulders up to 9 7/16" and shaft extensions up to 8 5/16". For data on both designs, send for Catalog 390.

SAF medium-duty pillow blocks contain the new SKF spherical roller bearings which offer 25 to 50% increased capacity, 2 to 3½ times longer life.



SDAF pillow blocks are designed for heavy-duty applications and also contain the new SKF spherical roller bearings.

5917

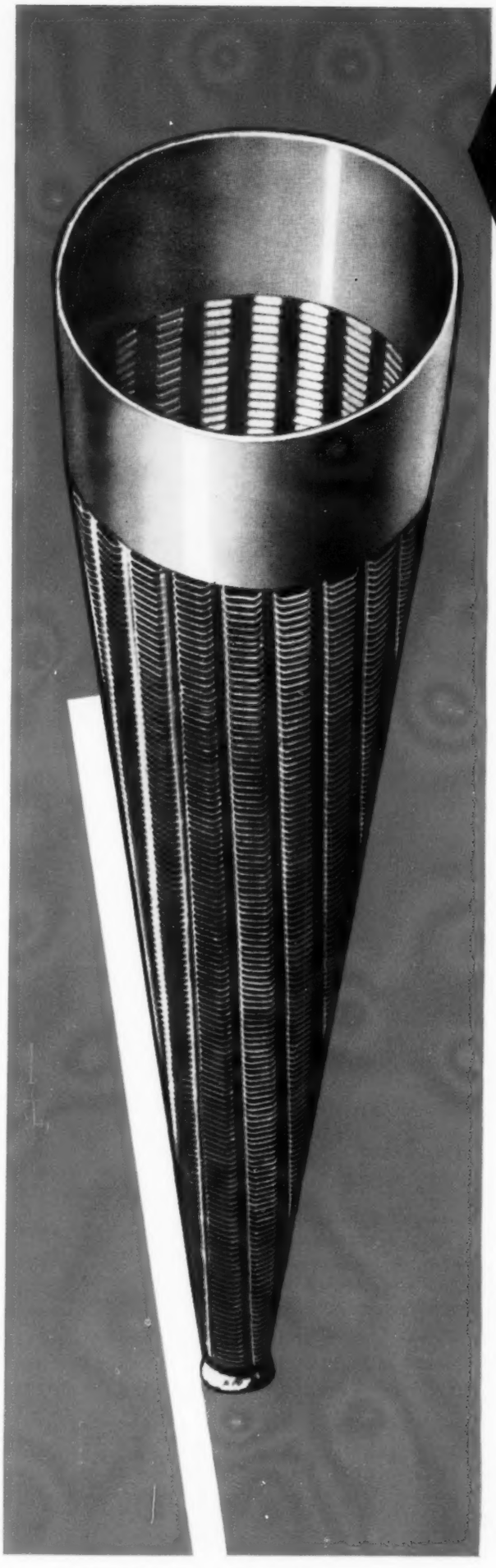
Spherical, Cylindrical, Ball, and Tyson Tapered Roller Bearings

EVERY TYPE—EVERY USE

SKF®

SKF INDUSTRIES, INC., PHILADELPHIA 32, PA.

® REG. U. S. PAT. OFF.



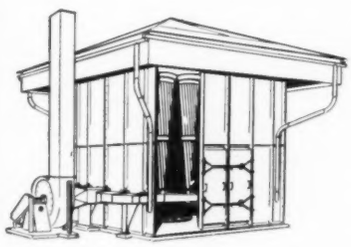
with this

INLAND®

CHECKED **TURBO-BLOWER** BLADE CUTTING

With this Green AERODYNE Dust Collector, Inland Steel checked turbo-blower fan blade cutting.

Green AERODYNE Dust Collectors eliminate coke breeze, coal dust, ferrous oxides and other abrasive dusts that wear out high-speed turbo-blower blades.



AERODYNE Dust Collectors are also used to clear combustion air for gas turbines. Oil bath and other types of filters requiring constant maintenance are eliminated by AERODYNE, as the collected dust is returned to the atmosphere. Dust disposal problems are eliminated.

You, as did Inland Steel, will find this cost-cutting story of interest. A word to Green will bring you the details.

Green

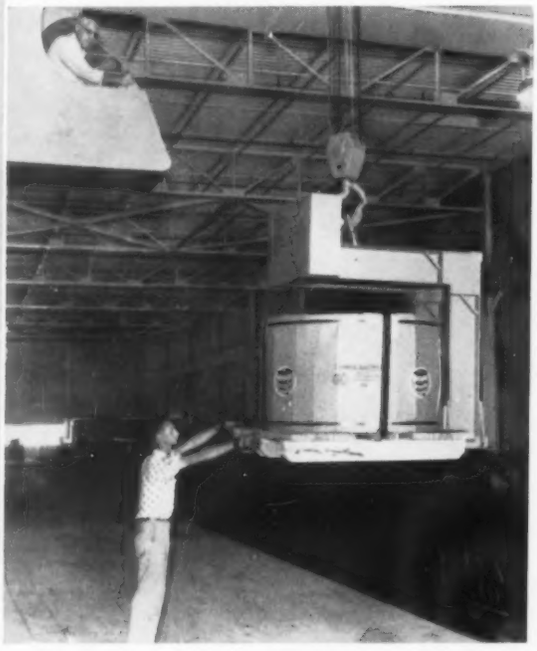
THE GREEN FUEL ECONOMIZER CO., INC.

BEACON 3, NEW YORK

MANSAVER® GRABS

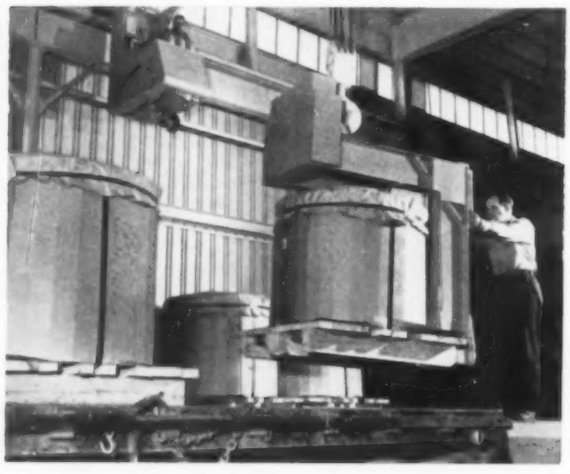
Handle Millions of Tons in Your Industry

Tinplate Coils . . . By Gondola—or



In the foreground, as usual, Mansaver Pallet Grabs are used by the steel industry and can makers for their new method of handling coils instead of sheets. Skids with coils are handled from gondola, as above, or by truck, as below, taken to the platform and made available to lift trucks or taken direct to storage and stacked three or four high.

Tinplate Coils . . . By Motor Truck



This Mansaver Style 1274-M Pallet Grab was especially designed to eliminate coil damage. Where conditions permit, entire handling can be done by overhead crane.

MANSAVER INDUSTRIES, INC.

3116 East St., New Haven, Conn.

Also Manufactured in England

DeZURIK VALVES

give you more at lower cost!

EASY OPERATION

DeZurik Valves open and close EASILY because the plug touches the valve body ONLY when the valve is closed. Pivoting the plug eccentrically means no binding, no scraping, no scoring.

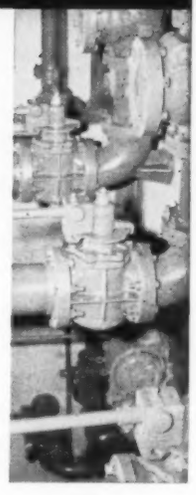
TIGHT SHUT-OFF

Dead-tight shut-off is guaranteed—every time—by the resilient facing on the plug of a DeZurik Valve. There's no chatter, no leaking, when you install DeZurik Valves.

WITH ECCENTRIC ACTION

NO MAINTENANCE

Because of their eccentric action and resilient-faced plugs, DeZurik Valves need no lubrication to provide easy operation and deliver tight shut-off. No guns or greases to stock, no lube schedule to maintain. And no stem leakage.



LONGER LIFE

DeZurik Valves last longer on tough services. Their resilient-faced plugs resist erosion on abrasive flows—and they can be furnished in a wide variety of trim for corrosive flows.

DeZurik Valves are available in sizes from ½" thru 20". See the DeZurik representative in your area or write for details.

DeZURIK CORPORATION

SARTELL, MINNESOTA

"We've cut stainless costs with ferromanganese-silicon"

Ferromanganese-silicon allows savings of as much as $8 per ton, depending upon practice, in the production of high-manganese stainless steels. It also reduces manganese costs for the chromium-nickel grades of stainless.

The alloy is both an efficient slag reducing agent and the lowest-priced source of low-carbon manganese currently available. For details on cost reductions in your practice, contact your UNION CARBIDE METALS representative.

UNION CARBIDE METALS COMPANY, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y.

Ferromanganese-silicon gives lower costs, rapid solubility, and high manganese recoveries.

UNION CARBIDE METALS

Electromet *Brand Ferroalloys and other Metallurgical Products*

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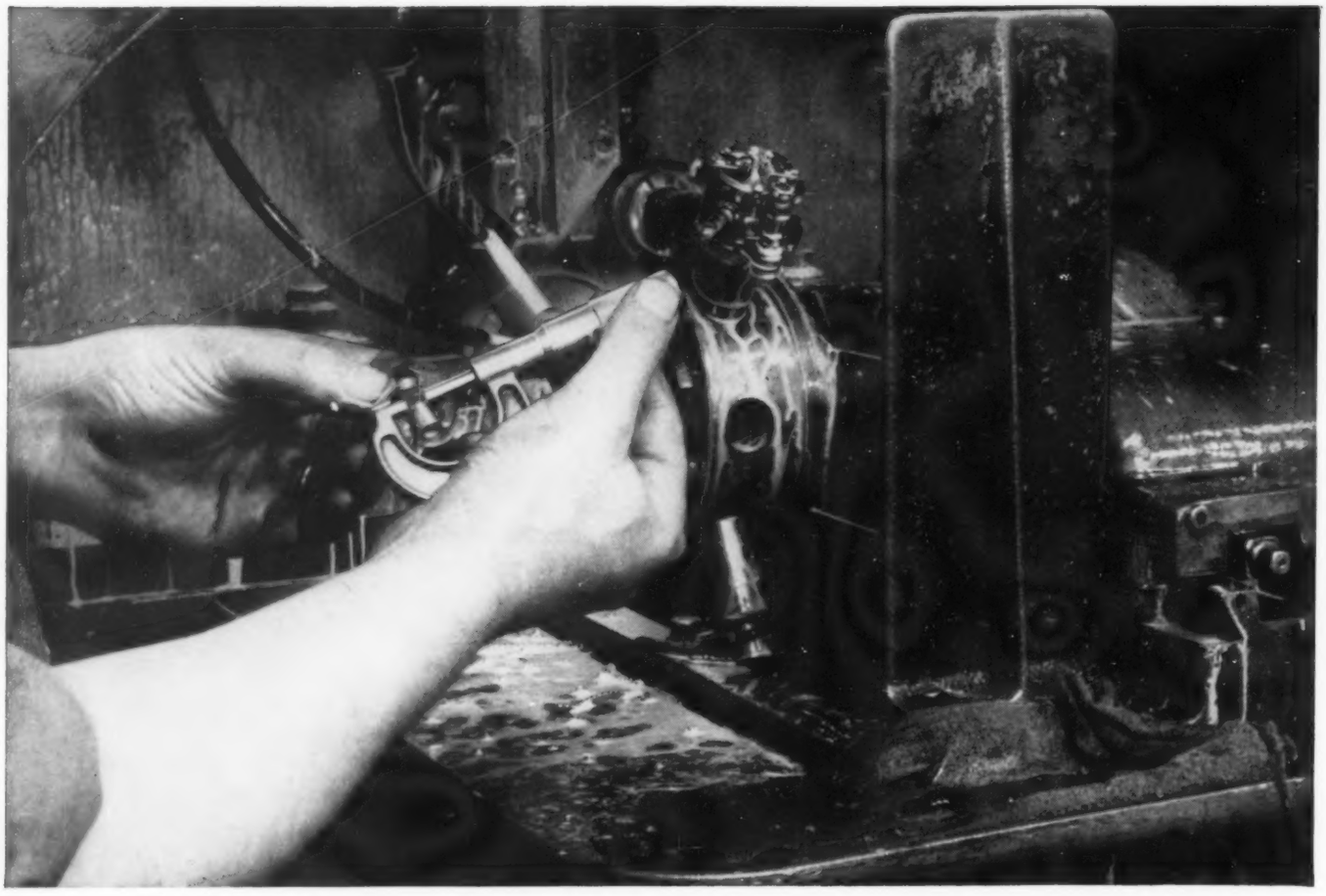


Machinecraft gets .0005″ tolerances with Cities Service Chillo Cutting oils!

Machinecraft, Inc., of Whitman, Massachusetts, makes a product that is surely the answer to many a textile man's fondest wish.

In place of old-style solid arbor top rolls, which often drip lubricant onto the fabric, Machinecraft has developed "the anti-friction top roll."

Operating on ball bearings, this unique invention requires almost no lubrication, therefore eliminates staining problems. In addition, it permits higher speeds of operation and produces more uniformly woven fabric.

In all of this, extremely intricate machining is required —and Cities Service Chillo Cutting Oil plays a crucial role.

Using Cities Service Chillo "A," Machinecraft is actually achieving tolerances as fine as .0005″! Moreover, Machinecraft reports that Chillo "A" gives "excellent tool life, produces a fine finish, has unusual stability, and offers continuous quality from batch to batch."

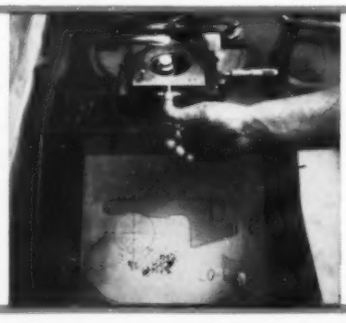
"In addition," continues this well known firm, "Cities Service provides us with exceptional technical assistance and good delivery service."

There's little to add to what Machinecraft says except a reminder that *you* can expect similar results with Cities Service, too. Talk with a lubrication engineer from the nearest office. Or write: Cities Service Oil Company, Sixty Wall Tower, New York 5, N. Y.

CITIES SERVICE

QUALITY PETROLEUM PRODUCTS

Machinecraft's Anti-Friction Top Roll is rapidly replacing old-style solid arbor type top rolls in textile mills. It prevents staining, permits greater operating speeds.



Shadowgraph is method of checking accuracy of precision machined parts for anti-friction top roll. Machine magnifies and projects the part's shadow outline. Tolerances are as fine as .0005″.

Date-line Diary...

March 2

Δ The AISI reports that the operating rate of the steel industry for the week of March 2 is scheduled at 2,535,000 tons (89.5 per cent of capacity). This compares with 2,506,000 tons one week ago (88.5 per cent capacity) and 1,425,000 tons one year ago. Index of production for the week is 157.8.

Δ Auto output in February, 1959 totaled 478,484 cars, which was 12.3 per cent under January, 1959 production, but 22 per cent over production in February, 1958.

March 4

Δ Copper prices by custom smelters were increased ½¢ per lb to 31½¢.

March 5

Δ The Commerce Dept. reported that manufacturers inventories on January 31 totaled $49,500,000,000, up $300,000,000 from a month earlier, but $3,400,000,000 under the January 31, 1958 total.

Δ Lone Star Steel Co. reports 1958 net income of $1,064,697 equal to 33¢ per share, compared with 1957 net income totaling $11,329,508 or $3.55 a share.

Δ Allis Chalmers Manufacturing Co., sales for 1958 amounted to $531,972,829, net profit $19,657,958 equal to $2.34 per share, compared with 1957 sales totaling $534,146,214, net profit $17,819,251 equal to $2.11 per share.

March 6

Δ The Aluminum Assn. reported that shipments of aluminum sheet and plate in January, 1959 totaled 105,880,000 lb, compared with 107,596,000 in December, 1958. Shipments of aluminum foil for January, 1959 totaled 18,754,376 lb compared with 17,880,053 lb in December, 1958.

Δ Federal Reserve Banks in New York, Philadelphia, Chicago, and Dallas increased discount rates to 3 per cent, up ½ per cent.

Δ Pittsburgh Coke & Chemical Co. reported 1958 sales amounting to $45,513,000, earnings totaling $1,296,000, equal to 75¢ a share; compared with sales amounting to $54,111,000, earnings of $2,739,000, or $2.02 per share in 1957.

Δ The Bureau of Mines reported that production of Pennsylvania anthracite for February, 1959 was 1,557,000 net tons compared with 2,194,000 in January, 1959 and 1,782,000 in February, 1958.

March 9

Δ Copper prices were increased 1½¢ to 31½¢ a lb by major U. S. producers.

Δ The AISI reports that the operating rate of the steel industry for the week of March 9 is scheduled at 2,600,000 tons (91.8 per cent of capacity). This compares with 2,556,000 tons one week ago (90.3 per cent capacity) and 1,463,000 tons one year ago. Index of production for the week is 161.9.

Δ The AISI reports that shipments of finished steel products for January, 1959 totaled 6,186,168 net tons, an increase of 12 per cent over December, 1958 shipments.

March 10

Δ The Assn. of American Railroads estimated major railroads net income in January, 1959 amounted to $22,000,000, up $4,000,000 over January, 1958.

Δ Dominion Foundries & Steel report for the year 1958 net income of $11,236,150 equal to $3.12 a share, compared with 1957 sales of $8,428,278 equal to $2.54 a share.

Δ Eastern Stainless Steel net income in 1958 amounted to $2,535,776 equal to $3.54 a share, compared with $1,831,952 equal to $2.78 a share.

Δ The AISI reported that the iron and steel industry's payroll for 94.9 per cent of the industry for hourly and salaried employees totaled $332,350,807 during January, 1959, against $325,334,615 in December, 1958 and $284,219,513 in January, 1958. Average hourly payroll cost for wage earners was $3.306, compared with $3.291 in December, 1958 and $3.042 in January, 1958. Fringe benefits amounting to 33.2¢ per hr are not included. Total employment during January, 1959 totaled 554,636 compared with 547,902 in December, 1958; average hours worked per week in January was 38.1 compared with 37.3 in December, 1958, and 35.1 in January, 1958.

March 11

Δ The Commerce Dept. estimated retail sales in February, 1959 at $17,500,000,000, $100,000,000 over the January, 1959 volume.

Δ According to the AISI steel production in February, 1959 totaled 9,603,000 net tons, an increase of 285,000 tons over January, 1959 and nearly 3,821,000 tons over February, 1958.

Δ Avery C. Adams, head of Jones & Laughlin Steel Corp., estimates that steel production in the U. S. in 1959 will reach 115,000,000 tons, up from 85,000,000 tons in 1958.

March 12

Δ Interlake Iron Corp. report sales in 1958 amounting to $84,636,952, net proft $2,835,454 or $1.26 a share; compared with 1957 sales of $108,937,912, net profit of $6,893,599 or $3.08 a share.

Δ American Iron Ore Assn. reports that the consumption of iron ore in the U. S. in January, 1959 totaled 9,827,765 gross tons; receipts of ore at iron and steel plants in the U. S. for January, 1959, totaled 3,164,290 gross tons; stocks on hand on January 31 was 59,071,292 gross tons of 261 blast furnaces, some 202 were in operation on January 31, 1959 compared with 165 in operation on January 31, 1958.

March 13

Δ Armco Steel will offer $75,000,000 debenture issue about April 1, for partially financing of a property improvement and expansion program.

March 16

Δ The AISI reports that the operating rate of the steel industry for the week of March 16, is scheduled at 2,610,000 tons (92.2 per cent of capacity). This compares with 2,604,000 tons one week ago (92.0 per cent capacity) and 1,417,000 tons one year ago. Index of production for the week is 162.5.

March 17

Δ According to annual report of the International Nickel Company of Canada, Limited, net earnings in 1958 amounted to $39,665,000 or $2.71 a share; in 1957 net earnings totaled $86,141,000 or $5.90 per share.

Δ The Material Handling Institute, Inc. index shows the dollar volume of orders in January, 1959 at 115.84, compared with 105.97 in December, 1958 and 93.07 in January, 1958 (using 100 as the monthly average for the statistical base year 1954).
Δ The Federal Reserve board reported that industrial output in February rose to 144 per cent of the 1947–49 average, which was one point above the January, 1959 level.
Δ The Commerce Dept. reported that personal income, on a seasonally adjusted annual rate, rose to $364,500,000,000 in February, 1959, an increase of $1,500,000,000 over January, 1959.
Δ Custom smelters increased copper prices to 34¢ a lb, an increase of 2¢ over the former quotation and 2½¢ above the current charge of major U. S. copper producers.

March 18

Δ Federal surveys indicate an outlay of $31,800,000,000 in 1959 for new plant and equipment, compared with $30,500,000,000 in 1958.
Δ Retail auto sales for the first third of March, 1959 averaged 16,645 cars daily, an increase of 4 per cent over the first third of February, 1958, and up 23 per cent over the same period in 1958.
Δ The Interior Dept. set new mandatory quotas limiting imports of crude and unfinished oil to 936,770 barrels daily, down 176,730 barrels from the level under voluntary curbs.
Δ The ARCI reports that deliveries of new freight cars in February, 1959 totaled 2486 cars compared with 1940 in January, 1959 and 5316 in February, 1958. New orders for February, 1959 amounted to 1806 compared with 4007 in January, 1959 and 287 in February, 1958. Backlog of cars on order as of March 1, 1959 was 28,789 compared with 29,470 on February 1, 1959 and 43,750 on March 1, 1958.

March 19

Δ Blaw-Knox Co. annual report for 1958 showed sales amounting to $167,709,000, net earnings $6,932,000 equal to $3.84 per share compared with 1957 net profit of $7,007,000 or $3.88 per share.
Δ Allegheny Ludlum Steel Corp. reduced base prices of a number of vacuum melted alloys.
Δ The Industrial Heating Equipment Assn. reported that new orders for industrial furnaces in February, 1959 were $2,741,000 compared with $3,518,000 in January. New orders for induction equipment for February, 1959 totaled $1,147,000 compared with $1,004,000 in January, 1959.

March 23

Δ The AISI reports that the operating rate of the steel industry for the week of March 23, is scheduled at 2,627,000 tons (92.8 per cent of capacity). This compares with 2,631,000 tons one week ago (92.9 per cent capacity) and 1,366,000 tons one year ago. Index of production for the week is 163.5.
Δ The Aluminum Assn. reported that primary aluminum production in the United States during February, 1959 was 142,116 short tons compared with 156,708 short tons in January, 1959 and 121,980 short tons in February, 1958.

March 24

Δ President Eisenhower advocated extending jobless pay to cover 3,200,000 more workers and also proposed application of payroll taxes to the first $4,200 on employees yearly compensation instead of the present $3,000.
Δ The Supreme Court placed variable annuity sales under the jurisdiction of the SEC and reversed a lower court ruling that the policies are insurance, subject to regulation by state insurance authorities.
Δ Incoming business to machine tool producers in February, 1959 amounted to $45,000,000 compared with $41,000,000 in January, 1959 and $28,000,000 in February, 1958.
Δ Ingot steel production in January, 1959 in Japan amounted to 1,153,000 metric tons; blast furnace production in January, 1959 totaled 662,000 metric tons.
Δ The AISC reported that bookings of fabricated steel in February, 1959 totaled 294,367 tons, compared with 235,784 tons in January, 1959, and 185,646 tons in February, 1958; shipments in February, 1959 amounted to 216,127 tons compared with 224,260 tons in January, 1959 and 282,576 tons in February, 1958. Backlog of future work amounted to 1,863,791 tons.

March 26

Δ According to the F. W. Dodge Corp. report construction contracts in the U. S. (excluding Alaska) totaled $2,300,000,000 in February, 1959.

March 30

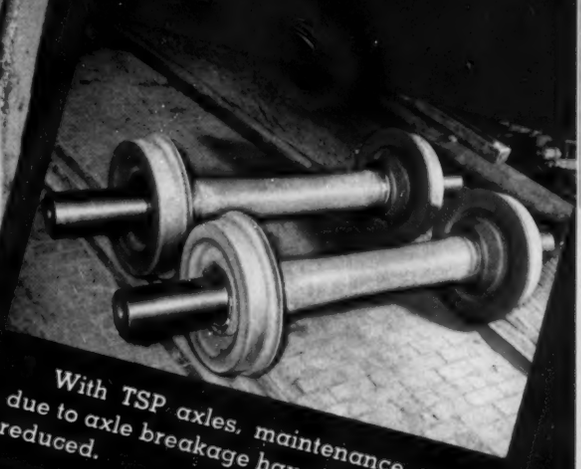
Δ The AISI reports that the operating rate of the steel industry for the week of March 30 is scheduled at 2,653,000 tons (93.7 per cent of capacity). This compares with 2,631,000 tons one week ago (92.9 per cent capacity) and 1,312,000 tons one year ago. Index of production for the week is 165.2.
Δ C. M. White, chairman of Republic Steel Corp., predicted that steel industry production in the first half of 1959 should be close to 60,000,000 tons, compared with 38,000,000 tons in the first half of 1958; and "steel output for all 1959 may reach 110,000,000 tons."
Δ The Commerce Dept. reported that commercial exports of the U. S. in February, 1959 dropped to slightly under $1,200,000,000, off $74,000,000 from February, 1958.
Δ The Labor Dept. reported that workers drawing unemployment compensation decreased to 2,164,600 in the week ended March 14, down 78,900 from the previous week. Since mid-February the total has fallen off 305,000, compared with an increase of 134,000 in the same period of 1958.

March 31

Δ D. J. McDonald and R. C. Cooper announced that commencing May 18, 1959 individual steel company meetings with union representatives will be scheduled, then negotiations will be recessed until June 1 to be resumed, primarily, by a four-man team on each side. Union representatives will be David J. McDonald, I. W. Abel, Howard R. Hague, and Arthur J. Goldberg. Twelve companies, including Allegheny Ludlum Steel Corp., Armco Steel Corp., Bethlehem Steel Co., Colorado Fuel and Iron Corp., Great Lakes Steel Corp., Inland Steel Co., Jones & Laughlin Steel Corp., Kaiser Steel Corp., Republic Steel Corp., United States Steel Corp., Wheeling Steel Corp., and The Youngstown Sheet and Tube Co., will be represented by R. Conrad Cooper and R. H. Larry, United States Steel Corp.; H. C. Lumb, counsel for Republic Steel Corp., and John H. Morse, counsel for Bethlehem Steel Co.
Δ Regional advisory boards estimated second quarter rail shipment loadings at 6,300,000 cars, 12.4 per cent over the like 1958 period. Loadings for 1959 through March 21 were 5.9 per cent over a year ago.

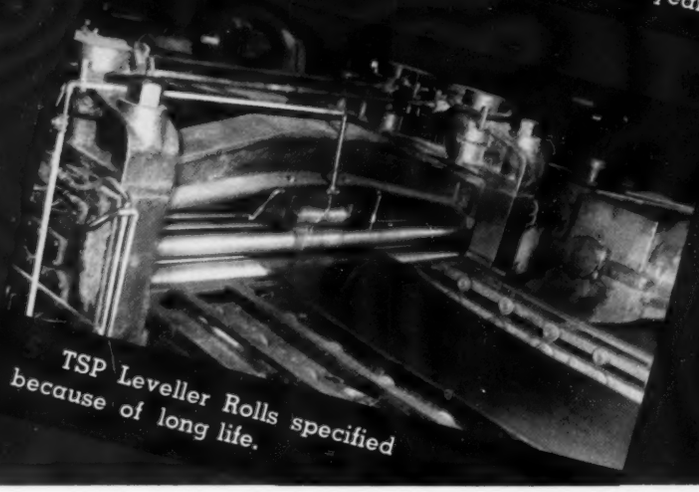
TSP Bevel Gears on mill approaches and delivery tables—very rough service. TSP gears are lasting several times longer than others formerly used.

TSP Liners used on Great Lakes blooming mills. TSP Liners have lasted for years.



With TSP axles, maintenance costs due to axle breakage have been greatly reduced.

TSP Helical Gear on edging mill, under extreme wear conditions for over a year, shows little sign of wear.



TSP Leveller Rolls specified because of long life.

here are 5 reasons why Great Lakes Division of National Steel uses TSP products

THE TOOL STEEL GEAR AND PINION CO
CINCINNATI 16, OHIO, U. S. A.

AD No. 1011

The Standard of Quality Since 1909 for Gears • Pinions • Rolls • Wheels and Other Hardened Products

HERE'S WHY: TSP products are hardened by our special process. The file hard surface to full depth of permissible wear gives maximum life. The core, refined for toughness and ductility, gives maximum strength. You receive an absolutely positive written guarantee that TSP products will give longer life in the same service than any other product.

Still ANOTHER Cottrell Advancement By Western Precipitation...

UNIQUE "FULL-RANGE" RAPPER CONTROL PROVIDES ENTIRELY NEW STANDARDS OF VERSATILITY

Rapping Frequency...Rapping Intensity...Rapping Pattern

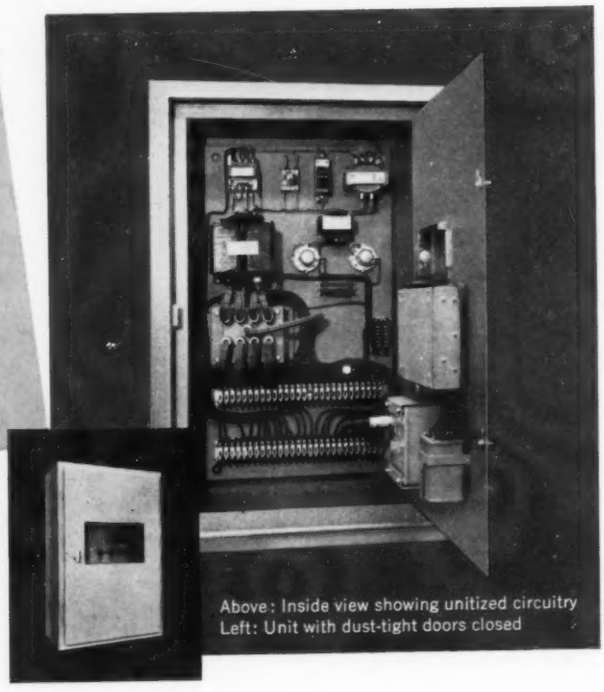
ALL EASILY ADJUSTABLE TO MEET OPERATING REQUIREMENTS

THE PROBLEM:

In the operation of Cottrell Precipitators it is necessary to remove the dust, fume or fly ash that has collected on the plates and cause it to be deposited in a hopper for subsequent removal from the Precipitator. The Rapping System should accomplish this removal with minimum disturbance to the already collected material (to avoid re-entrainment) and with maximum cleaning of the plates.

However, collected materials vary widely in their physical characteristics. Some are sticky. Some agglomerate readily and in thick layers without disrupting electrical operation. Still others have no tendency whatever to agglomerate, but form a sheet of loose particles on the plate.

There is no "typical" dust—no fixed set of conditions to be met. **Yet the Rapper System must be readily adaptable to efficient dust removal, regardless of dust characteristics!**



Above: Inside view showing unitized circuitry
Left: Unit with dust-tight doors closed

THE SOLUTION:

With so many variables to be compensated, unusually wide adjustability of the Rapper System has long been a prime objective for optimum operating efficiency. But complex factors have prevented its attainment until development of Western Precipitation's new "Full Range" Rapper Control.

By simply adjusting a few dials, "Full Range" Control permits:

- **FULL FREQUENCY ADJUSTMENT** from a complete rapping cycle every 50 seconds to one every 3½ hours...or any desired cycle in between!
- **FULL INTENSITY ADJUSTMENT** from zero to maximum over an unusually wide range!
- **FULL PATTERN ADJUSTMENT** 2, 4 or 8 impacts per cycle can be selected, with each cycle varying from light to heavy on successive impacts within the cycle—all automatically controlled to a choice of pre-selected operating limits!

Other Important Advantages...

Greater Safety: The "Full Range" Control has no dangerous high voltage circuits to endanger personnel. Entire unit is in "low-voltage" category.

All "Passive" Design: There are no motors, gears, or other high maintenance components in the "Full Range" Control. It is completely electronic.

Space-Saving Compactness: The "Full Range" Control requires about *half* the space of previous designs. Also is water and dust tight—can be located virtually anywhere.

Unitized Circuitry: All related parts are unitized into separate "cans" for simplified maintenance.

Free! NEW BROCHURE which describes and illustrates the new "Full Range" Rapper Control—the latest product of Western Precipitation's program of continuous advancement!

For quick assistance, call or wire **collect** *our nearest office.*

A-M-101

COTTRELL Electrical Precipitators
MULTICLONE Mechanical Collectors
CMP Combination Units
DUALAIRE Jet-Cleaned Filters
THERM-O-FLEX Hi-Temp Filters
TURBULAIRE-DOYLE Scrubbers
HOLO-FLITE Processors
HI-TURBIANT Heaters

WESTERN
PRECIPITATION
CORPORATION

Engineers and Constructors of Equipment for Collection of Suspended Material from Gases . . . and Equipment for the Process Industries

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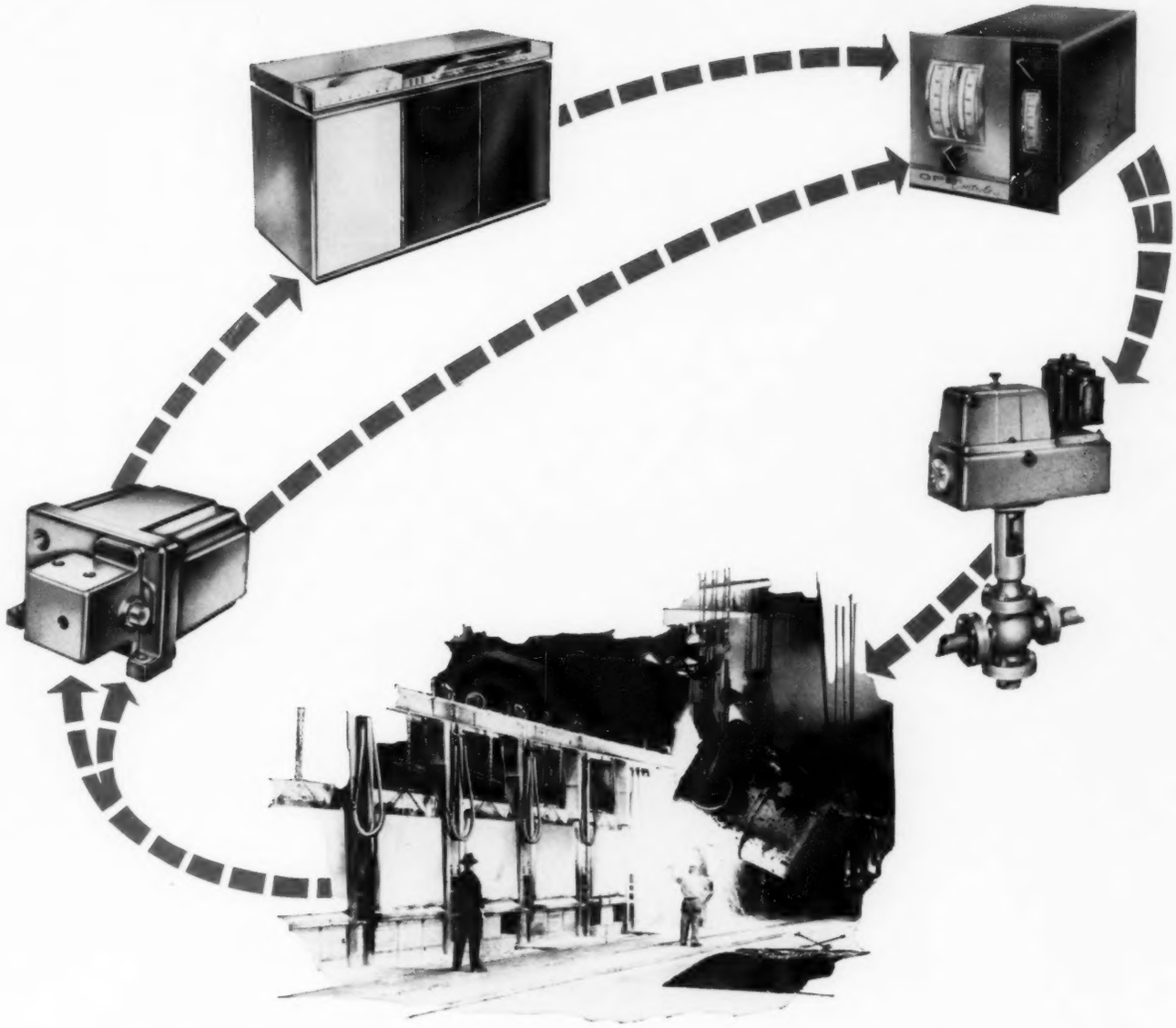
Representatives in all principal cities

Precipitation Company of Canada Ltd., 8285 Mountain Sights Avenue, Montreal 9



GPE Controls can close the loop in computerized process control

You can realize the benefits of modern computerized process control—today—because GPE Controls, Inc. can supply closed-loop system components manufactured by its own divisions and designed to operate together.

- **Transmitters for process variables, and controllers—made to operate with computers**
- **The Libratrol-500 digital computer . . . with built-in analog-to-digital input and digital-to-analog output**
- **Link expandable special-purpose data-processing systems**
- **Electro-hydraulic valve actuators from 200 to 200,000 lbs. thrust**

These performance-matched components, coupled with a quarter-century of experience in industrial automatic controls, assure optimum performance whether you need a closed-loop system or an expandable data-processing system.

GPE Controls | A GENERAL PRECISION COMPANY

Write for information on this unique GPE Controls service

GPE Controls, Inc. (formerly Askania Regulator Company)
240 East Ontario Street • Chicago 11, Illinois

A Subsidiary of GENERAL PRECISION EQUIPMENT CORPORATION

OHIO IRON AND STEEL ROLLS

Carbon Steel Rolls	Flintuff Rolls	Denso Iron Rolls
Ohioloy Rolls	Double-Pour Rolls	Nickel Grain Rolls
Ohioloy "K" Rolls	Chilled Iron Rolls	Special Iron Rolls
Nioloy Rolls	Forged Steel Rolls	

The Ohio Steel Foundry Co.

LIMA, OHIO

LIMA... Virtually at the center of the steel industry

PLANTS AT LIMA AND SPRINGFIELD, OHIO

Industry News...

ARMCO ADDS FURNACES AT BALTIMORE WORKS

△ A $775,000 expansion program to increase Armco Steel Corp.'s stainless steel output has begun at the Baltimore, Md., Works.

Two new double ingot heating furnaces and three new heat-treating furnaces are to be installed.

The ingot heating furnaces will permit the production of increased tonnages of special grades of stainless steel. With the additional heat-treating furnaces, the plant will have more capacity for the controlled cooling or heat treating of billets before they are transferred to other rolling mills or shipped.

The new furnaces will be in operation in about six months.

MILL CONTRACT AWARDED TO LOEWY-HYDROPRESS

△ The Wisconsin Steel Division of International Harvester Co. has ordered the rolling mill equipment for its new $12,000,000 merchant mill from Loewy-Hydropress Division of Baldwin-Lima-Hamilton Corp.

The concept of this fourteen-stand continuous bar mill is new. Six 16-in. stands and four 14-in. stands are followed by four 12-in. finishing combination mill stands which can—within minutes—be changed from horizontal to vertical setup, thus avoiding any twisting of the material and resulting in perfectly sound products.

A 350-ft long skew roller type cooling bed will be specially equipped for pack-annealing for handling of spring steel.

The mill is designed for a product mix including rounds, squares and other bar products as well as angles, channels and merchant sections, flats and spring steel.

Billet and flying shears, repeaters and looping equipment, individually driven roller tables and electronically controlled coilers reduce labor to a minimum.

The contract also includes rebuilding of four existing 21-in. break-down mills and the design and supply of new auxiliary equipment such as billet unscrambler, furnace pushers, shears and conveyors.

LEADED STEEL DEMAND ON THE INCREASE

The demand for leaded steel has almost doubled among automatic screw machine users in the past year. As a result, United States Steel Corp. opened new bessemer leaded steel production facilities at its National Tube Division Works at Lorain, Ohio. Some 46.6 per cent of all steel bar stock used in automatic screw machines in 1958 was leaded, whereas in 1957 only 25 per cent of the stock used in the high speed machines was leaded.

In addition to providing an exceptionally fine finish, leaded steel is specially formulated to permit increased spindle speeds and to allow increased feed rates with all types of tools. Manufacturers using automatic screw machines are also swinging toward leaded steel for it helps cut costs by increasing the tool life. The bessemer and open-hearth leaded steels can be ordered in all the usual sizes of rounds, squares, hexagons and flats. In the figure, as molten steel streams from the ladle into an ingot mold below, tiny pellets of lead shot (7 lb per ton of steel) are sprayed into the metal. The lead comes from the pressure storage tank, at left, into the gun controlled by operator standing behind the tank. Fume exhaust hoods extend to the top of each ingot.

J&L TO BOOST PLANT'S OPEN HEARTH CAPACITY

△ Plans for increasing open hearth capacity at the Pittsburgh Works of Jones & Laughlin Steel Corp. have been announced.

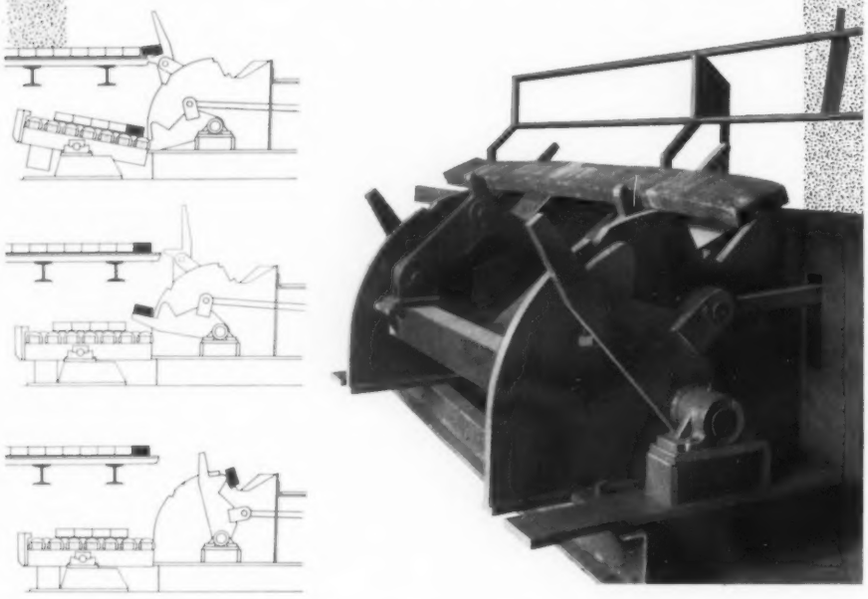
Monthly rated capacity at J&L's No. 4 open hearth shop, a modern 11-furnace unit, will be increased in the first phase of the program by approximately 15,000 tons from the present figure of 195,000 net tons of ingots per month. Plans for additional phases of the program have not been completed.

The first phase will be accomplished by increasing the average size of heats in the existing furnaces from about 280 tons to 310 net tons, and through the purchase of new and larger steel ladles. Heat size can be increased to the 310-ton figure in the existing furnaces by increasing the amount of charged materials.

Eighteen of the new ladles have been ordered from Pennsylvania Engineering Corp.; and from Treadwell Construction Co. The ladles

The New EVANS SLAB and BILLET TURNER

for faster, lower cost steel conditioning



- Fast positioning, turning and unloading
- Easy accessibility for scarfing and inspection
- Complete operator control

Specialists in the design and manufacture of special turning equipment, Evans engineered this new slab and billet turner to cut costs two ways—by increasing production and reducing handling costs. Used with a feed mechanism, the turner swiftly positions either slabs or billets one piece at a time. Positive turning action brings each edge or face into convenient work position and then quickly unloads the work piece onto a delivery rack.

The operator's platform is clean and uncluttered. Simple push button operation affords him complete control, and easily controlled position variation insures efficient scarfing and inspection.

Rugged all-weld construction and positive mechanical linkage provides capacity for handling slabs up to 14 inches wide in 10 to 30 foot lengths, or billets of the same length, and any cross section, within the turner's 6000 pound weight limit.

Consult Evans for specialized engineering assistance to help cut turning and handling costs and boost production. Write for a new two-color brochure that fully describes Evans' Special Turning Equipment.

EVANS ENTERPRISES
INCORPORATED
MASSILLON, OHIO

now in use are of 280-ton average capacity.

ANNOUNCE FORMATION OF ENGINEERING FIRM

△ Formation of a company known as C. F. Simmers Inc., located in Canfield, Ohio, has been announced. The newly organized corporation will specialize in heavy crane, rolling mill and allied equipment design and industrial and steel plant layout and studies.

Mr. Simmers was formerly vice president of engineering of the Morgan Engineering Co., having advanced to that position in 1955 after serving from 1948 in various positions. He had 16 years with U. S. Steel Corp. and one year with United Engineering & Foundry Co. in various engineering posts.

The plans for the new company, in addition to serving the domestic steel companies, include licensing agreements for design services with steel producers in Europe, South America, South Africa and Asia. It is estimated that 40 per cent of the new company's business would originate with such licensing agreements.

COMPANY WILL EXPAND HIGH POWER LABORATORY

△ The Westinghouse Electric Corp. has announced plans to expand and increase the capacity of its high power laboratory at East Pittsburgh, Pa. The facility is used for testing large power circuit breakers for the purpose of verification and development of new designs.

The $3,000,000 expansion program was disclosed by L. B. McCully, vice president of the firm's East Pittsburgh division. He said construction will begin this summer and will add approximately 20,000 sq ft to the present facility. The project is expected to be completed within 18 months.

"With the short circuit capacity of electric utility systems doubling every 10 years, a demand is constantly created for higher power circuit breakers and higher power testing facilities," Mr. McCully pointed out. "Expansion of our present high power laboratory will enable our power circuit breaker department to improve its product design and to maintain its competitive position," he added.

. . . . . What's the limit: Heat? Shock? Speed? Or complicated radial and thrust loads?

Name the combination of requirements . . . and chances are you'll find them met by a Rollway Maximum precision radial cylindrical roller bearing. If not, then Rollway engineers will modify any factor to meet your application.

Rollers are crowned to prevent end-loading and the resultant spalling of races. Directional trueness is maintained by retainers of standard bronze or "Rollube" ferrous alloy of one piece or two piece construction.

You may wish to refer to the Rollway Catalog and Engineering Data Book when writing specifications for a high precision bearing. It contains the first listing, by any manufacturer, of the thrust capacities of cylindrical radial roller bearings. Send for it today.

ENGINEERING OFFICES:

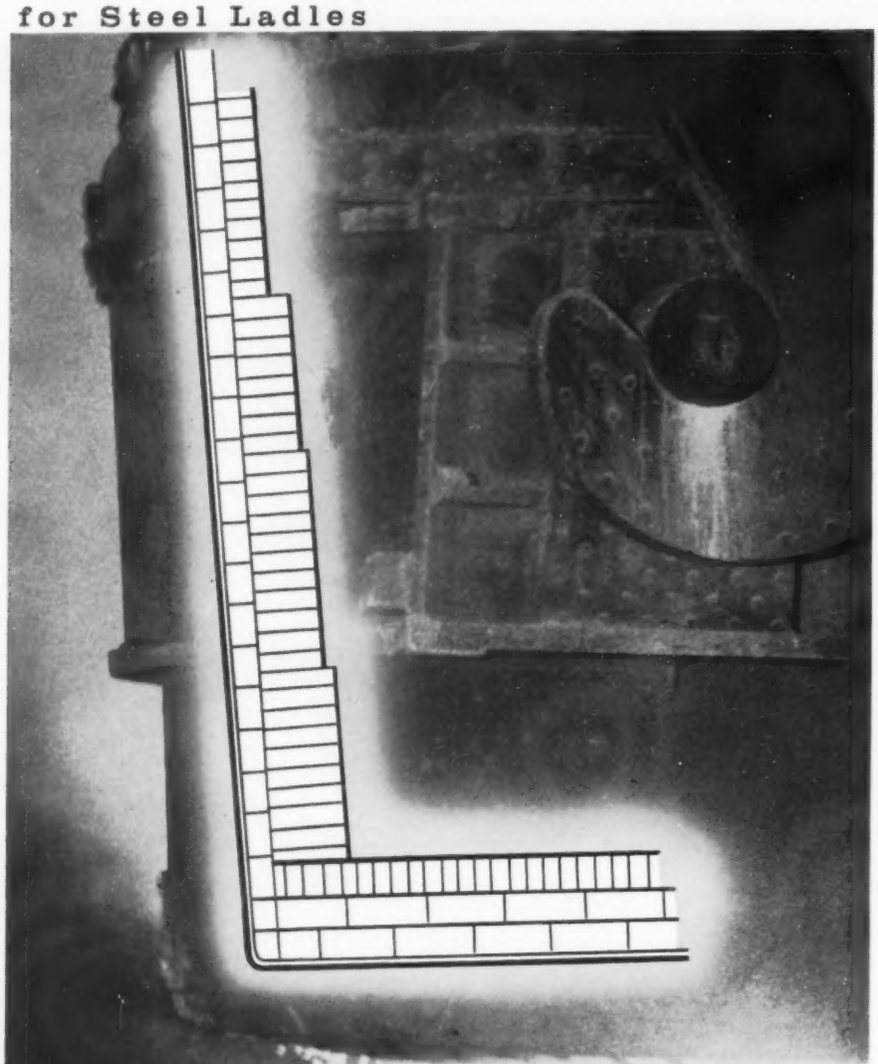
Syracuse Boston Chicago Detroit
Toronto Pittsburgh Cleveland
Seattle Houston Philadelphia
Los Angeles San Francisco

ROLLWAY®
BEARINGS
COMPLETE LINE OF RADIAL AND THRUST CYLINDRICAL ROLLER BEARINGS

DANDO

CHORD BRICK LININGS

for Steel Ladles



over 8,000 tons of steel before relining

That's the kind of record DANDO Chord Brick are making. And this tonnage is matched by an economical first cost. These same price and performance factors will give *you* a lower ladle cost per ton of steel.

Why not investigate DANDO Chord Brick Linings for your ladles? Write *McLain Works, Refractories Division, H. K. Porter Company, Inc., Porter Building, Pittsburgh 19, Pa.*

REFRACTORIES PORTER DIVISION

H.K. PORTER COMPANY, INC.

DIVISIONS: Connors Steel, Delta-Star Electric, Disston, Forge & Fittings, Leschen Wire Rope, Mouldings, National Electric, Refractories, Riverside-Alloy Metal, Thermoid, Vulcan-Kidd Steel, H. K. Porter Company (Canada) Ltd.

Westinghouse, in 1924, became the first electrical equipment manufacturer to construct a large high power laboratory primarily for testing power circuit breakers.

Prior to the construction of the Westinghouse high power laboratory at East Pittsburgh, information on breaker arc-interrupting ability was obtained only through field tests.

L. A. Kilgore, director of engineering at the East Pittsburgh division, explained the expansion program will greatly increase the testing capacity of the high power laboratory.

An enclosed service area for the adjustment of circuit breakers, laboratory space for engineering activities and the necessary electrical equipment to expand the capacity of the present laboratory will be housed in this building.

A new generator, transformers, capacitor and reactor banks, and other auxiliaries will be included, said Mr. Gilgore. Provisions have also been made to expand the central control room of the laboratory. An electrical computer will be added to the facility which will be used in making the transformer and reactor settings.

MACHINERY BUILDING COMPANY IS FORMED

△ Northeast Ohio Machine Builders, Inc., Columbiana, Ohio, has been formed to serve the metals industries with specially-designed machinery and equipment.

President and general manager of the new company is Wm. K. Stamets, Jr., who formerly was president and chief engineer for The Enterprise Co., a vice president and director in the Wm. K. Stamets Co.

John R. Longabaugh, formerly mechanical engineer for Enterprise, Koppers Co., and Martin Aircraft Co., has been appointed sales manager for the new firm.

INLAND TO MODERNIZE CHICAGO HEIGHTS PLANT

△ An extensive modernization and rehabilitation program of the original plant of Inland Steel Co., built in 1893 in Chicago Heights, Ill., was announced by John F. Smith, Jr., president.

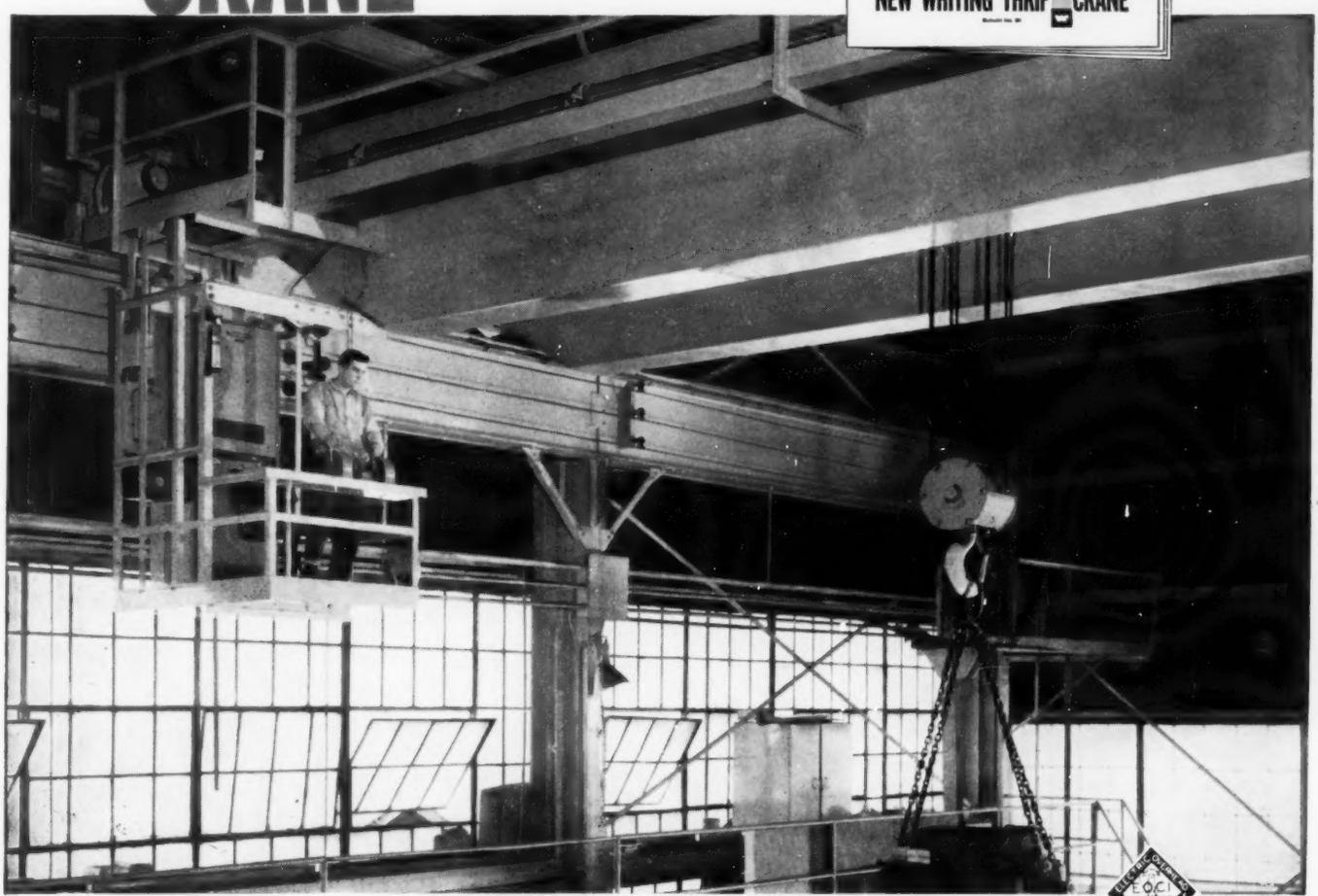
The program, scheduled for completion in 1960, will convert the

NEW THRIF-T CRANE

SEND FOR NEW BOOKLET
Bulletin 91 giving detailed information.

Keep your capital investment down

with the
NEW WHITING THRIF-T CRANE



An Answer to Plant Modernization

Whiting's new Thrif-T Crane is slated to spark a trend in plant modernization. It's a husky crane. It has plenty of stamina to do big jobs with the speed demanded by today's production schedules and cost levels. *Yet, it costs much less than you'd expect!* Pre-engineering, mass-produced parts . . . and a host of exciting new design developments enable new Thrif-T Crane to provide big-crane performance at small-crane cost. *Whiting Corporation, 15655 Lathrop Avenue, Harvey, Illinois.*

87 OF AMERICA'S "FIRST HUNDRED" CORPORATIONS ARE WHITING CUSTOMERS

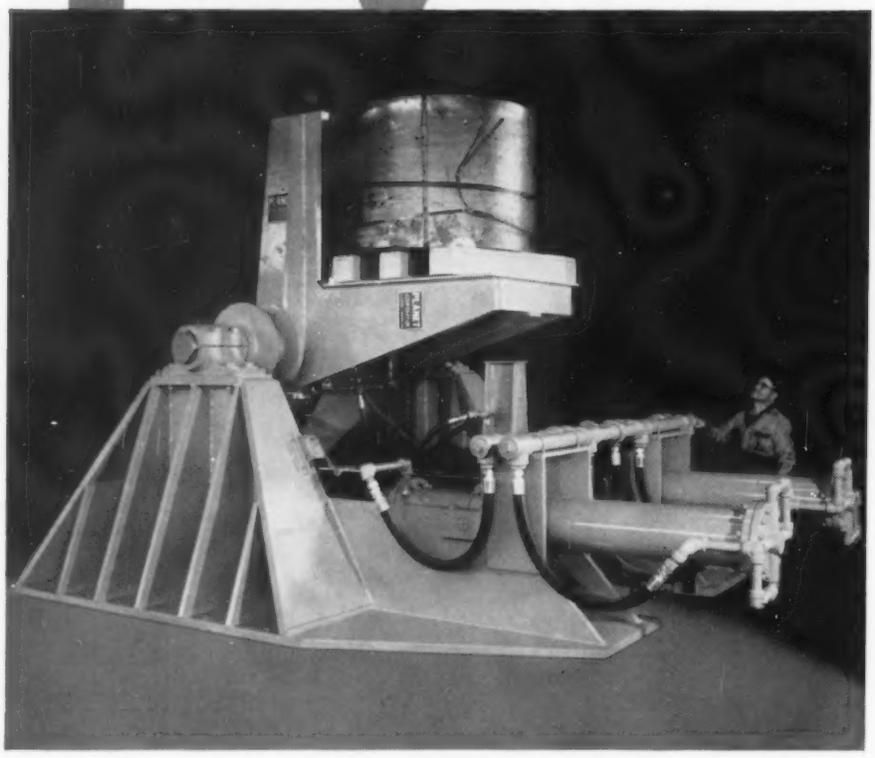
WHITING

75th year

CRANES

MANUFACTURERS OF CRANES; TRAMBEAM HANDLING SYSTEMS; TRACKMOBILES; FOUNDRY, RAILROAD, AND CHEMICAL PROCESSING EQUIPMENT.

PV
PLANET VERSATILITY...



HEAVY DUTY UPENDER
TURNS 50,000 LB. STEEL COIL

Planet Corporation's Upender is another example of why Planet is known throughout industry as a versatile organization . . . and as an organization which manufactures quality equipment. Planet's Upender turns 50,000 pound coils from a horizontal position to vertical, or vice versa, and it is made to take day in, day out abuse. Although upenders are not unique (as is most of Planet's equipment) it is evidence of Planet's competence in creating and building even the heaviest of materials handling equipment.

PLAN WITH PLANET If your plant has a production, materials handling, or automation problem, let Planet demonstrate how its versatile engineering skill, and production and erection know-how can help you. It has paid many leading industrial concerns whose names are household words to "Plan with Planet" . . . *it will pay you too to use Planet Versatility.* Write or phone today!

PLANET
CORPORATION
• ENGINEERED HANDLING SYSTEMS
• AUTOMATION EQUIPMENT
• FOUNDRY HANDLING EQUIPMENT

1816 SUNSET AVENUE
LANSING, MICHIGAN

92

plant, a rail rerolling mill, into the largest and most modern of its type in the country, according to Mr. Smith.

In addition, he said, it will raise the plant's capacity 75 per cent from 80,000 tons to 140,000 tons a year. In periods of high demand the modernized mill would supplement the capacity of the company's merchant mills at its Indiana Harbor, Ind., steel plant by processing billets produced there into a variety of merchant bar products.

The program calls principally for a new reheating furnace to replace an obsolete furnace 65 years old, modernization of the rolling mills with the addition of new rolling stands and motors and extension of the rolling mill building to accommodate the additional equipment, improvements in finishing facilities and expansion of the electrical power and water distribution systems.

These changes will enable the plant to go from a two to three shift daily operation, Mr. Smith explained, pointing out that with the present old equipment a third shift is now devoted to changing rolls for the following day's operations.

The reheating furnace scheduled for replacement was Inland's first furnace, dating back to the company's founding in 1893 with the building of the Chicago Heights Works, its sole operation until 1902 when it built its first open hearth furnaces at Indiana Harbor.

The new furnace will provide faster and more uniform heating than the original, thereby enabling the plant to get the additional heating capacity required by its 75 per cent over-all output boost.

A modernized electrical system will provide the plant with more power, and improvements in water distribution will result from the installation of a recirculating system which will also conserve the city's deep well water source.

Auxiliary installations are included in the program as well as relocation of equipment and enlargement of buildings.

Inland's Chicago Heights works converts used railroad rails and steel billets into a variety of products, including concrete reinforcing bars, fence posts, bulbed tees, sub purlins, angles, automobile bumper brackets and jacks.

LINDE packaged oxygen plant sets nine-year record for availability!

THE LINDE oxygen plant shown here has been serving a leading chemicals producer "over-the-fence" continuously since 1949. Its operating log shows a 98%+ availability factor. Next year, capacity will go up from 360 to 800 tons of oxygen a day.

You can expect the same continuity of supply with a LINDE packaged plant serving your process. Your LINDE plant will be the product of fifty years' experience in the design, manufacture, and operation of air separation plants and low temperature equipment. LINDE is uniquely qualified to provide air separation plants for the supply of oxygen and/or nitrogen as well as the associated low temperature equipment for:

liquefying hydrogen, helium and fluorine
purifying hydrogen and helium
separating hydrogen from coke oven gas
ammonia and methanol synthesis
upgrading of natural gas
other extremely low temperature processes.

Put LINDE's more than 50 years' experience in gas separation techniques to work for you. Write Dept. IR-4, LINDE COMPANY, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N.Y. *In Canada:* Linde Company, Division of Union Carbide Canada Limited.

"Linde" and "Union Carbide" are trade-marks of Union Carbide Corporation.

Linde
TRADE-MARK

UNION CARBIDE

Industries that regularly require large quantities of oxygen or other atmospheric gases can obtain those they need from a LINDE plant on their own sites. The oxygen plant illustrated—built, owned, and operated by LINDE—is at a plant of one of the nation's largest chemical processors.

Cutler-Hammer 505 Mill Brakes end costly production interruptions at a large Midwest Steel Plant

Here's dramatic evidence Cutler-Hammer 505 Mill Brakes are designed right to work better and last longer. A large Midwest Steel Plant had been using another make of Mill Brakes on their mill screwdowns and found it necessary to interrupt production frequently to repair these brakes. The brakes required adjustment weekly . . . followed by monthly overhauls.

Then the brakes on one mill were replaced with 23" Cutler-Hammer 505 Mill Brakes, and the results were most amazing. The Cutler-Hammer 505 Mill Brakes worked continuously . . . perfectly with only minor adjustments for lining wear . . . and even these adjustments could be accomplished without halting the mill. As a result, the Shop Electrical Superintendent turned in a *Cost Reduction Report* prompting the plant's standardization on Cutler-Hammer 505 Mill Brakes.

This is positive proof of dependability . . . proof that Cutler-Hammer 505 Mill Brakes work better and last longer even under the most severe operating conditions. Why take chances with costly production interruptions? Specify Cutler-Hammer 505 Mill Brakes and be sure. For complete information write today for Bul. 505-H232. Cutler-Hammer Inc., Milwaukee 1, Wisconsin.

CUTLER·HAMMER
CONTROL
C·H

Cutler-Hammer Inc., Milwaukee, Wis. • *Division:* **Airborne Instruments Laboratory.** • *Subsidiary:* **Cutler-Hammer International, C. A.**

Associates: Canadian Cutler-Hammer, Ltd.; Cutler-Hammer Mexicana, S. A.; Intercontinental Electronics Corporation.

FELLER ENGINEERING CO.

presents

SCHLOEMANN

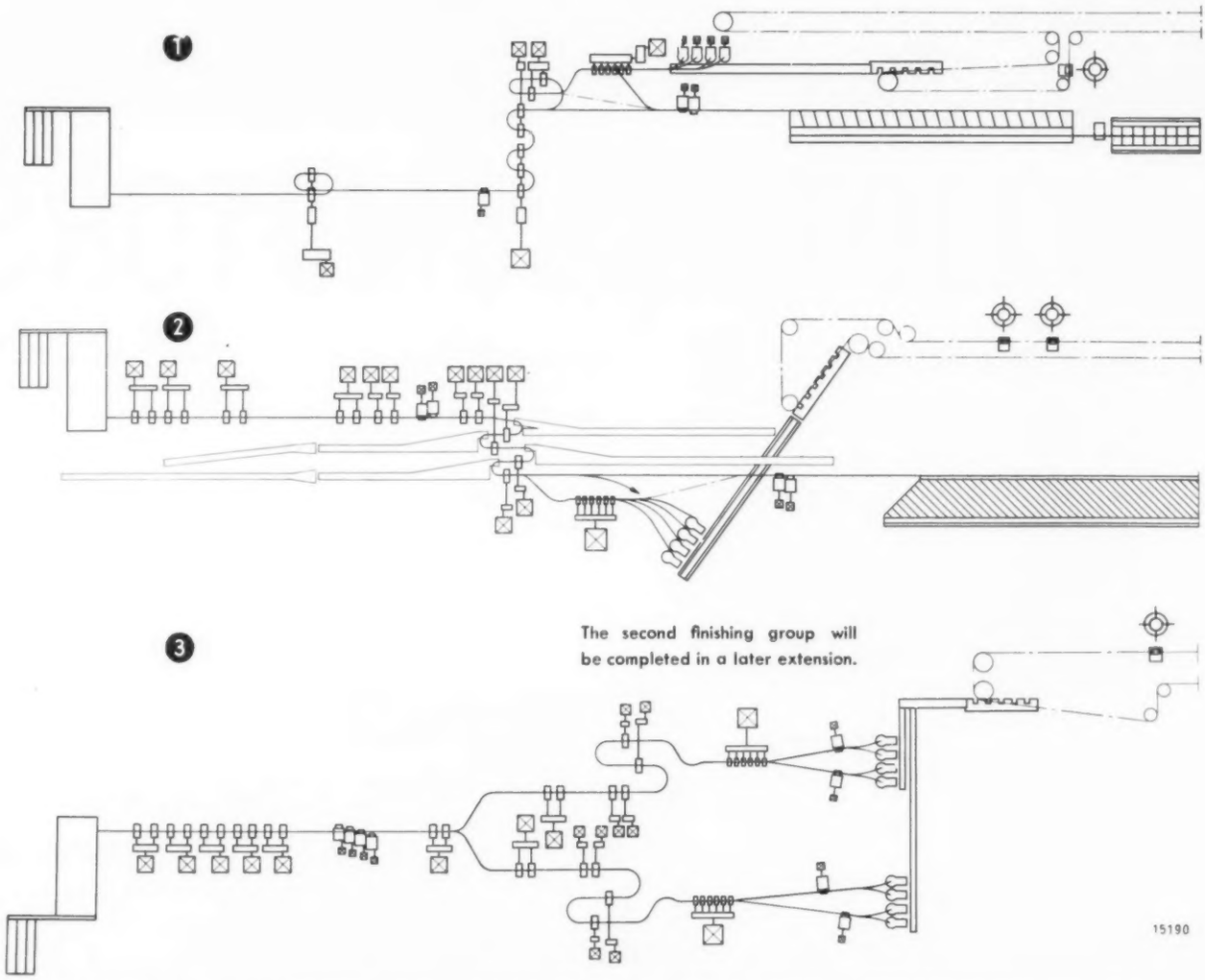
Modern wire rod and merchant mills

Three rolling mills with finishing trains in two-high twist layout

Tolerance requirements determine the layout of the finishing train for both wire rod and merchant bar mills. If tolerances of ±.008 or less must be held, the finishing train should be arranged for no tension single strand rolling with loops, at high speed, in alternating horizontal and vertical roll stands. In many cases, however, requirements are such that roller twisters, operating in combination with horizontal stands only, will suffice. If tolerances of ±.010 are adequate, several strands may be rolled in one train simultaneously. This simplifies the finishing train considerably, inasmuch as one common drive can be employed for the finishing stands arranged in tandem. At the present time SCHLOEMANN is building three complete mills in the two-high twist layout.

	Material (in inches)	Strands: roughing train	Strands: finishing train
1	¼ to 1 ○	1	2
2	5 rod to ⅝ ○	2	2
	¾ to 1¼ ○	1	1
	½ to 1 □	1	1
	¾ to 1½ ∟	1	1
	¾ to 1½ ⊥	1	1
	¾ x 3/16 ▭	1	1
	2 x ½ ▭	1	1
3	5 to ⅜ rod	4	2 x 2

Our next report will deal with wire rod and merchant bar mills having horizontal and vertical stands.



FELLER ENGINEERING CO., 1161 EMPIRE BUILDING, PITTSBURGH 22, PA.

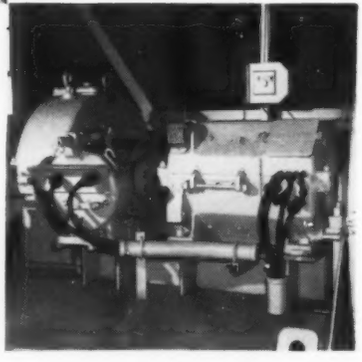
from ships

In 1904, Crocker-Wheeler introduced the first "mill type" motor—built to steel men's specifications, bull-strong, and insulated with asbestos and mica.

ELLIOTT C-W MOTORS

Above: Driving the trolley turntable is this Elliott 603 frame, 13½-hp mill motor, seen in the foreground. In the background is one of the Elliott 616 frame, 187½-hp motors which power the trolley.

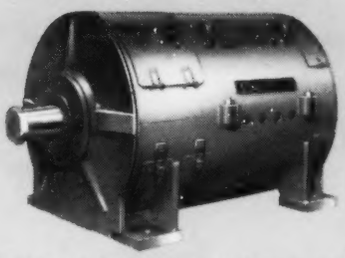
Right: One of the Elliott 612 frame, 94-hp, series-wound, adjustable-voltage mill type motors which drive the apron hoist in this gigantic operation.



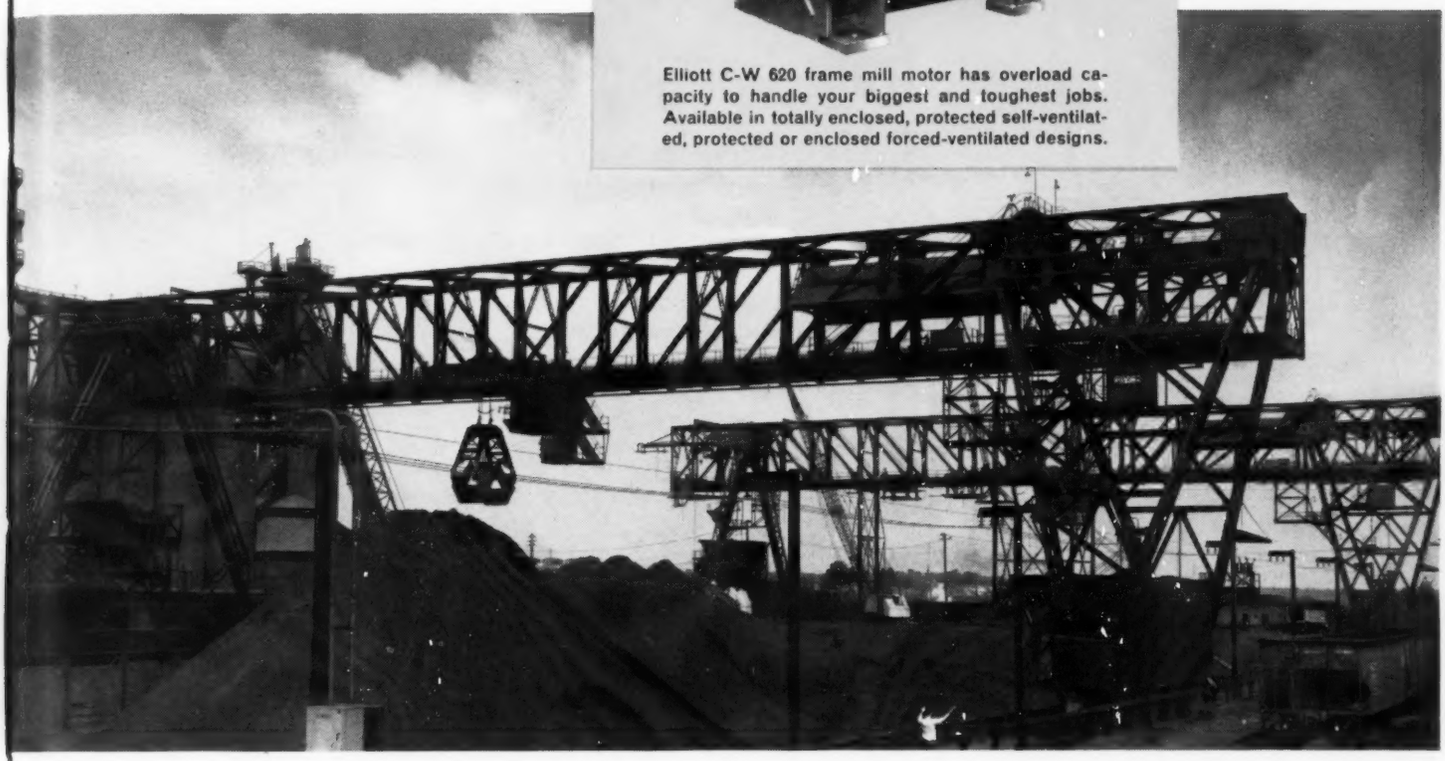
Elliott supplied all a-c and d-c motor drives, 10 to 800 hp, for the above trolley unloader. Use of d-c adjustable-voltage control on the bucket which scoops up a 22½-ton load every 45 seconds and trolley travel which transfers ore from ship to hopper assures smooth, precise control of all bridge movements. Auxiliary d-c mill motors drive the apron hoist, tower travel, rail clamp release and trolley turntable. The large, enclosed structure at the top houses mill motors, control equipment and the five-unit adjustable-voltage motor-generator set—all furnished by Elliott.

ELLIOTT
Company
Crocker-Wheeler Plant
Jeannette, Pennsylvania

to skips...

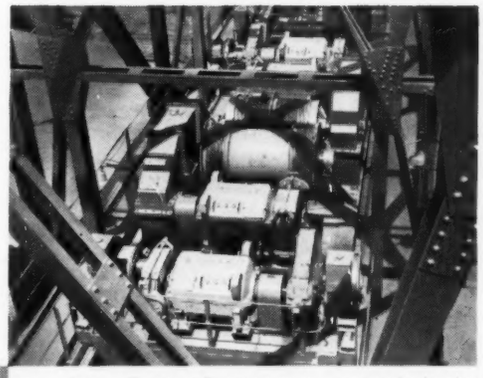


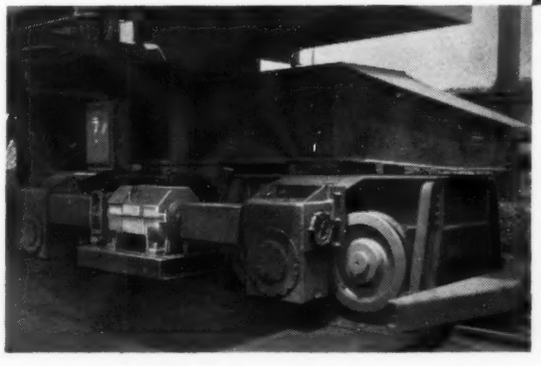
Elliott C-W 620 frame mill motor has overload capacity to handle your biggest and toughest jobs. Available in totally enclosed, protected self-ventilated, protected or enclosed forced-ventilated designs.



furnish the power to move mountains of ore

Elliott mill motors and motor-generator sets furnish the drives and power for the above gigantic bridges which move mountains of ore from steel mill ore yards to blast furnace hoppers, and subsequently, to skips. The mill motors, operated at double-rated voltage and double speed, are precision controlled from the operator's cab by three master switches and three foot-operated pushbuttons. All adjustable-voltage control equipment, a five-unit adjustable-voltage motor-generator set and all of the electrical drives for both bridges were furnished by Elliott Company.





Above: The two Elliott motors nearest the bucket drums are 250-hp hoist engine drives which hoist, open and close the bucket. Identical Elliott motors adjacent to these drive the trolley along its rails.

Left: One of the twin, two-rail trucks which support the bridge pier leg. Each truck is driven by an Elliott 100-hp mill motor. The opposite, or shear leg of the bridge is supported by two sets of single-rail trucks, also driven by 100-hp motors.

W9-6

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...and get it!

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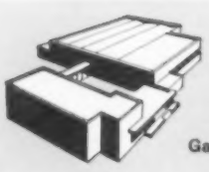
The superior manufacturing skills and broad experience along with the highly perfected quality control program are other exceedingly important factors in the fulfillment of the best refractories practice. Application engineering is based upon thorough familiarity with the requirements of all kinds of industrial furnaces and the potentialities of all the types and classes of refractories. By these highly developed techniques, Harbison-Walker provides the refractories which assure superior service.

World's Most Complete Refractories Service



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HARBISON-WALKER REFRACTORIES COMPANY

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Cylindrical roller bearings are manufactured in the variations shown above, as well as many others. They are supplied with separators of cast bronze or pressed steel. Some have a full complement of rollers, no separators.

Each *can* be called interchangeable with the other, yet *none* are. All variations are priced differently and each is designed to fit particular applications.

If you buy or authorize replacement bearing purchases, make certain you order by *all* suffixes and prefixes . . . Bearings, Inc. have complete stocks of all types in all sizes and can advise which is best for each application . . . Buy with confidence that the bearing you order will be the bearing you get. Call our nearest branch.

1. *Straight inner race; separator; retaining rings in outer race.*
2. *Single flanged inner race; separator; retaining rings in outer race.*
3. *Double flanged outer race; bronze separator; single flanged inner race.*
4. *Double flanged inner race; straight outer race; bronze separator.*
5. *Straight inner race; double flanged outer race; bronze separator.*
6. *Double flanged inner race; single flanged outer race; retainer on opposite side; non-separable; steel retainer.*
7. *Double flanged inner race; single flanged outer race, retainer on opposite side; non-separable; full roller, no separator.*

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NEW YORK: Buffalo, Balanrol Corp. • **MARYLAND:** Baltimore • **DELAWARE:** Wilmington

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Personnel News...

Samuel A. Ott has been elected vice president in charge of operations, Eastern Division. The Colorado Fuel and Iron Corp. Mr. Ott joined CF&I in 1956 as works manager of the Claymont Division. Prior to joining CF&I, he was superintendent of the Midvale, Co., chief metallurgist and assistant to the vice president at Pan-Ohio Steel Corp., and vice President and general sales manager of the Pittsburgh Alloy Corp. He began his professional career with the Follansbee Steel Corp., Toronto, Ohio, where he served as superintendent of the open hearth.

Harry M. Francis was elevated to the position of executive vice president of the American Steel and Wire Division, United States Steel Corp. In his new post Mr. Francis, who has been vice president—sales for the past 13 years, will co-ordinate activities of various departments of the Wire Division.

L. A. Fugassi, assistant chief engineer at Weirton Steel Co., division of National Steel Corp., has been appointed chief engineer at Midwest Steel Corp., the new plant which National Steel will build in northwestern Indiana.

Mr. Fugassi has been assistant chief engineer of Weirton since 1955. He will be succeeded by **J. M. Bendot,** chief draftsman. **J. W. Martt,** assistant chief draftsman, has been named chief draftsman. **William L. Barr** has been promoted from designer to assistant chief draftsman.

Mr. Fugassi began his career with Weirton Steel in 1935 as a field engineer. In 1936, he was sent to Zug Island, Detroit, to help with field engineering for Great Lakes Steel Corp., division of National Steel. He returned to Weirton in 1937 and entered the Engineering Department as a draftsman. He then moved up through the ranks to become a squad leader, development engineer, assistant chief draftsman, and in 1952 was appointed chief draftsman. He held this position until he was appointed assistant chief engineer in 1955.

Mr. Bendot started with Weirton steel in 1937 as a draftsman. In 1952 he was appointed assistant construction superintendent and at the start of the company's modernization program in 1953 was transferred to the Engineering Department. He was named chief draftsman in 1955.

Mr. Martt began his employment with Weirton Steel as a draftsman in 1947. He was promoted to project engineer in 1952 and became assistant chief draftsman in 1955. Mr. Barr came to Weirton in 1954 from Follansbee Steel Corp.

Fred A. Kaufman has been appointed vice president and general manager of Universal-Cyclops Steel Corp. In this newly created post, he will have responsibility for the direction of sales activities and the operation of the company's plants at Bridgeville and Titusville, Pa., and Coshocton, Ohio. Previously, Mr. Kaufman was vice president in charge of its Refractomet Division.

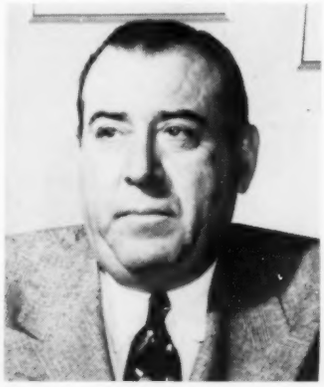
Dr. David R. Helman was appointed consulting computer engineer—operations analysis, in General Electric Co.'s Computer Department, Phoenix, Ariz. Dr. Helman previously developed logic design for General Electric's computers and was active in testing and evaluating the company's computer systems. He was also concerned with development of computer programs which control design data calculation. Prior to joining General Electric in 1956, Dr. Helman was engaged in logic designs of computer output-display devices and sales recording systems for Radio Corp. of America.

K. M. Patterson has been appointed to a newly created position as manager of headquarters sales departments for the Westinghouse Electric Corp.'s Apparatus Division in East Pittsburgh, Pa. Succeeding Mr. Patterson in his former position as manager of the division's industrial sales department is **C. E. Hammond** who was formerly assistant manager for the division's South Pacific district in Los Angeles, Calif.

Mr. Patterson joined Westinghouse through its graduate student training course in 1923. He served as a salesman and then became manager of the large motor sales section at East Pittsburgh in 1936. Mr. Patterson was appointed manager of the steel mill section of the industrial sales department in 1949 and then served as

S. A. OTT

H. M. FRANCIS



L. A. FUGASSI

J. M. BENDOT

M. L. GRUVER

J. K. SEYLER

C. M. ELLIOTT

H. G. COFFEY

manager of the latter department from 1952 until receiving his present assignment.

Mr. Hammond first became associated with Westinghouse when he entered the graduate student training course in 1946 and then served as a sales correspondent at East Pittsburgh. Later Mr. Hammond transferred to the apparatus division's office in San Francisco, Calif., where he became a sales assistant in 1947, salesman in 1948, and industrial resale manager in 1953 for the Pacific Coast Region. In 1957 he was appointed assistant manager of the apparatus sales district office in Los Angeles, the position he held until receiving his present assignment.

Merle L. Gruver has been appointed superintendent of the soaking pits, blooming mill, slabbing mill and structural mill at Kaiser Steel Corp.'s Fontana, Calif., plant. **A. D. Bachtel** will continue as superintendent of the conditioning yards, general yard material handling and rolling mills cranes. This realignment of supervisory responsibility has been effected in connection with the start-up of new facilities at the Fontana plant. Mr. Gruver came to Kaiser in 1955, joining the Plant Engineering Department. He was named staff engineer, rolling mills. The following year he was appointed supervising staff engineer in plant engineering and in September, 1958, was named engineer for the soaking pits, slabbing mill, structural mill, blooming mill and conditioning yards. Before joining Kaiser, he was superintendent of maintenance of Midvale Co. for five years in the manufacture of steel forgings. From 1947 to 1950, he was with H. K. Porter Co., Inc., serving as superintendent of that firm's original plant in Pittsburgh. Previously he was employed by Jones & Laughlin Steel Corp. as engineer in blooming and rolling mills areas.

Joseph K. Seyler has been appointed superintendent—Cold Finishing Department at the Pittsburgh Works of Jones & Laughlin Steel Corp., succeeding **H. W. Callahan,** who has retired. Mr. Seyler joined J&L as an inspector in the Metallurgical Department at the Pittsburgh Works in 1936, and was appointed assistant supervisor of that department in 1939. He was named assistant superintendent of the Cold Finishing Department in 1947, and was made superintendent in 1951. He has been assistant superintendent—Cold Finishing Department in charge of the Hazelwood operation since 1955. Mr. Callahan spent nearly 40 years with J&L. He joined J&L as a mill practice engineer at the Pittsburgh Works in 1919. He was appointed assistant superintendent—South Side Cold Finishing Department in 1922, and became superintendent in 1926. He has been superintendent of the combined cold Finishing Departments at Pittsburgh Works since 1947.

Clarence M. Elliott was named assistant electrical superintendent at Republic Steel Corp.'s South Chicago plant. He succeeds **Frank J. Zupancic,** who recently was named superintendent of the Electrical Department at Republic's Warren, Ohio, plant. Mr. Elliott has been with Republic at the company's Chicago plant since 1946.

H. G. Coffey, former president of The Aetna-Standard Engineering Co., has been named vice president-general manager of the Aetna-Standard Division of Blaw-Knox Co. The appointment was announced by W. Cordes Snyder, Jr., president of Blaw-Knox, following his company's acquisition of properties of Aetna-Standard. Transfer of ownership of the properties took place as of the close of business, February 28, 1959.

Edward C. Denne, Jr., was appointed by SKF Industries, Inc., to direct bearing development design and engineering services for heavy industrial applications. Mr. Denne joined SKF in 1953.

Edward D. Mesta has been named assistant sales manager, Mesta Machine Co. At the same time **Richard L. McIlavy** was named manager of machinery sales, and **John M. Edwards** assistant to the sales manager. Mr. Mesta served in the machine shops, inspection department, engineering department and was advertising manager and sales engineer prior to this appointment. Mr. McIlavy and Mr. Edwards previously served as sales engineers.

E. D. MESTA

R. L. MC ILAVY

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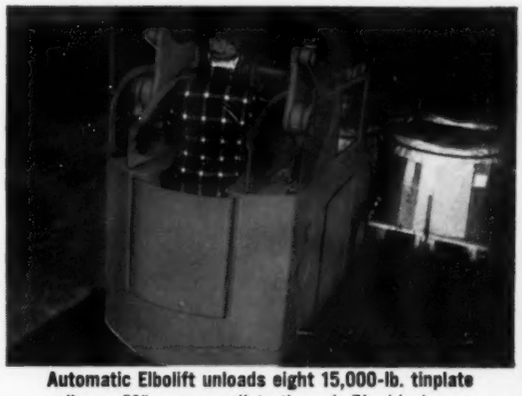
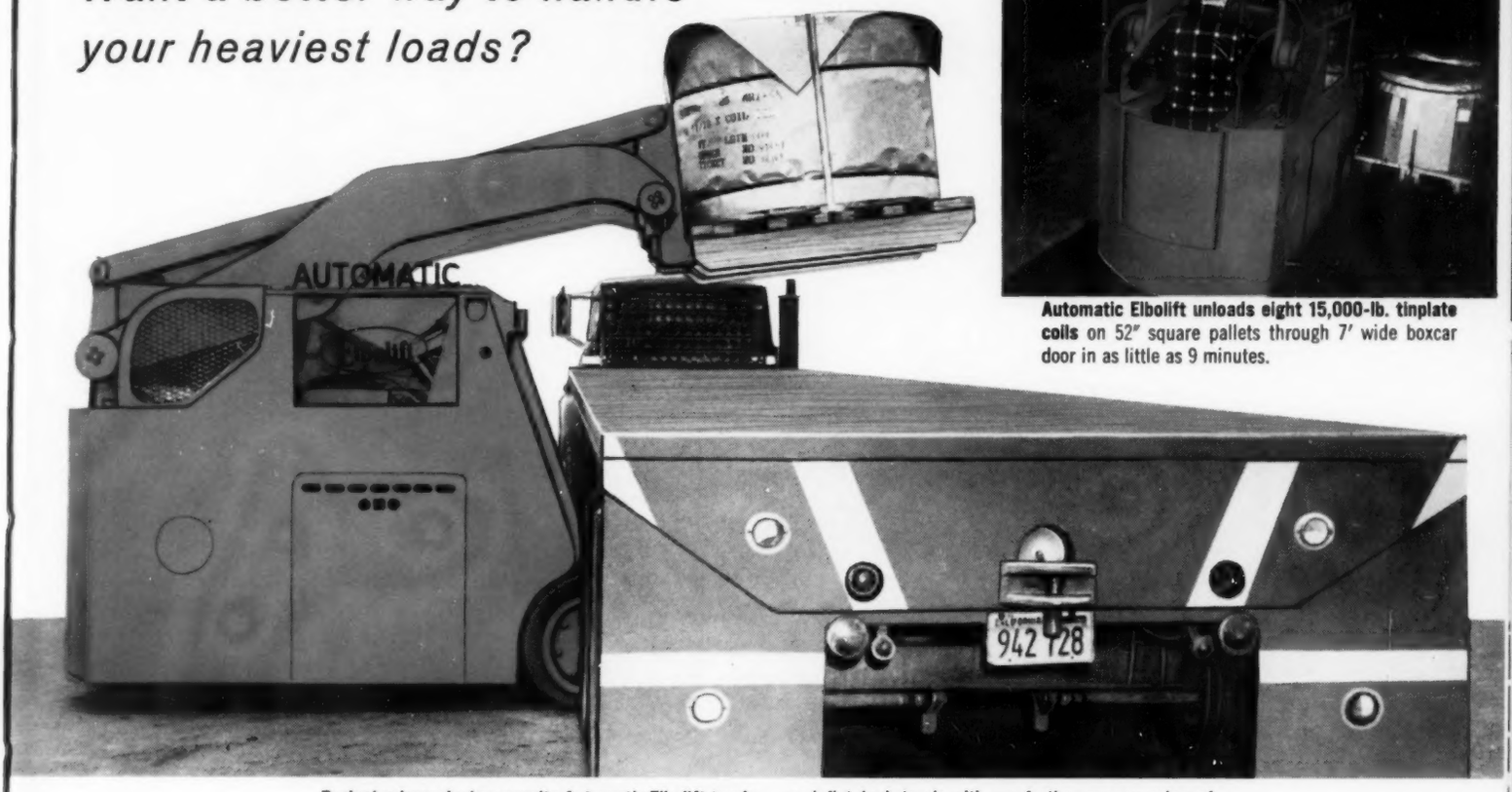
Want a better way to handle your heaviest loads?



Automatic Elbolift unloads eight 15,000-lb. tinplate coils on 52" square pallets through 7' wide boxcar door in as little as 9 minutes.



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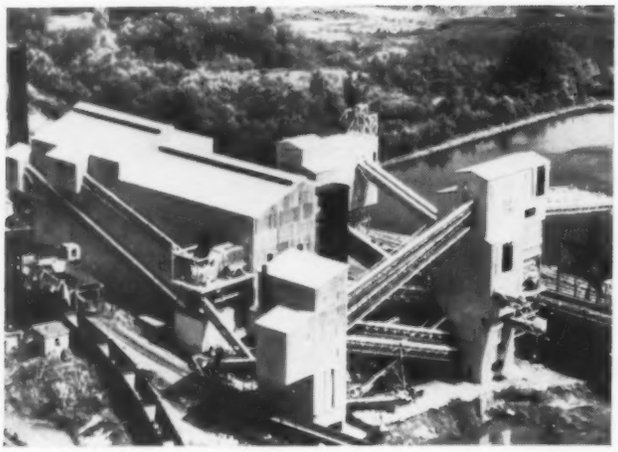
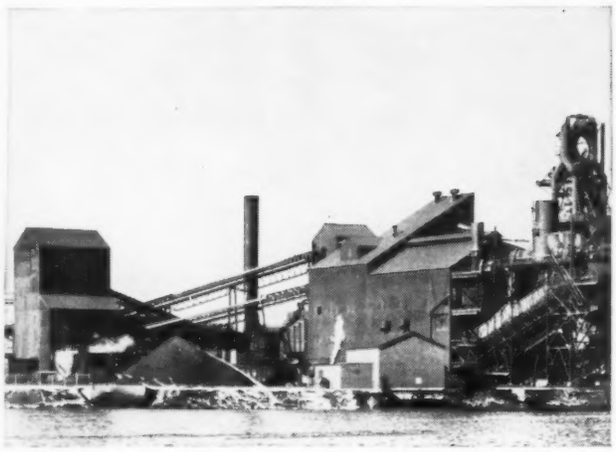
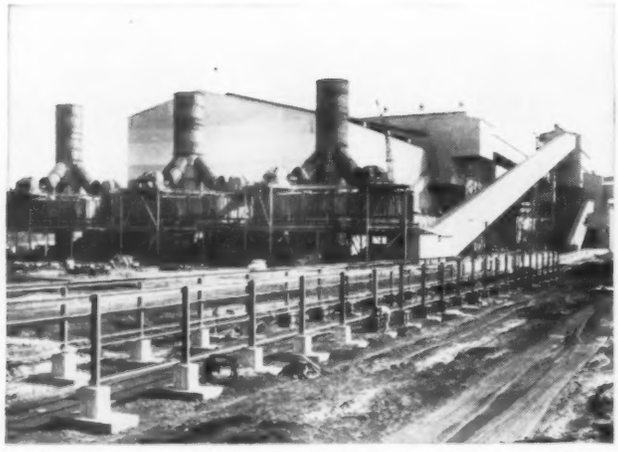


ARMCO



McLOUTH



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Sinter machine width: 13′ 2″

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E. S. MURRAH

ROGER KINNICUTT, JR.

W. J. HILL

J. H. HITCHCOCK

Edmund S. Murrah has been named director of engineering of the Morgan Construction Co.'s Rolling Mill Division. Mr. Murrah has served in various engineering capacities since joining Morgan in 1945. **Roger Kinnicutt, Jr.,** and **William J. Hill** have been appointed assistant chief engineers to serve under Mr. Murrah. Both were project engineers. **John H. Hitchcock** has been appointed chief consulting engineer for all company divisions from his former post as chief mechanical engineer of the Rolling Mill Division. Mr. Hitchcock joined Morgan as an engineer in 1933. **Bernard L. Burns** has been appointed manager of a newly formed department designated as the Design and Development Department. Mr. Burns has been with the company since 1920, and before his new appointment held the post of assistant chief draftsman.

A. J. Tomasek, since 1954, president of the Walsh Refractories Corp., has also been named chief executive officer and chairman of the board, to succeed **P. L. Hershfield.**

Harold W. Nelson has been promoted to technical director of Great Lakes Carbon Corp.'s carbon division. Mr. Nelson, formerly manager of research in the research and development department, will continue to be located at the company's research center in Morton Grove, Ill.

John P. Bankson has been appointed special sales representative, Engineering and Construction Division, Koppers Co., Inc. Prior to his recent appointment, he had been connected with the Ingot Mold Division of the Shenango Furnace Co. for three years as manager of sales. He has also served with General Refractories Co. where he was district sales manager, and with Harbison-Walker Refractories Co. where he served for the next 25 years in various sales capacities.

Warren G. Cudlip has been appointed manager of quantity sales at Cutler-Hammer, Inc. He had formerly managed the firm's Grand Rapids, Mich., branch sales office. He joined Cutler-Hammer in 1937, working first in the company's experimental department and later transferring to sales work. He had been manager of the Grand Rapids office since 1953.

Peter C. Rossin has been named general manager, Refractomet Division, Universal-Cyclops Steel Corp. He previously served as technical director of this division. **William L. Bruckart** was appointed manager of sales for Refractomet. He has been engaged in sales development for the company's refractory and reactive metal products for several years.

R. J. (Dick) Matteson has been appointed Eastern district engineer for the Hydraulic Controls Division, The North American Manufacturing Co. Mr. Matteson was formerly Eastern district manager for the Askania Regulator Co.

Carl W. Sisco was named district manager of Surface Combustion Corp.'s Pittsburgh sales office. **Robert M. Snyder** was appointed district manager, Steel Mill Division, Chicago office, and **Robert E. Strutner,** sales Engineer, Steel Mill Division, Toledo, Ohio.

Edwin H. Burke was named director of engineering, The Morgan Engineering Co. Mr. Burke succeeds **Charles F. Simmers,** vice president of engineering, who has resigned as chief engineering executive. Upon joining the company as chief mill machinery engineer in 1955, Mr. Burke took charge of developing designs for mill machinery. Prior to this present appointment, Mr. Burke's duties were expanded to include responsibility for engineering design of all cranes produced by the company.

He was employed for a time with Crucible Steel Co. of America as project engineer at the Midland Works, prior to joining Morgan.

R. L. Hoffman has been promoted to sales manager of Bloom Engineering Co., Inc. Most recently he had been manager of the company's Philadelphia sales office. He has served as development engineer and sales engineer since joining the company in 1949.

E. H. BURKE

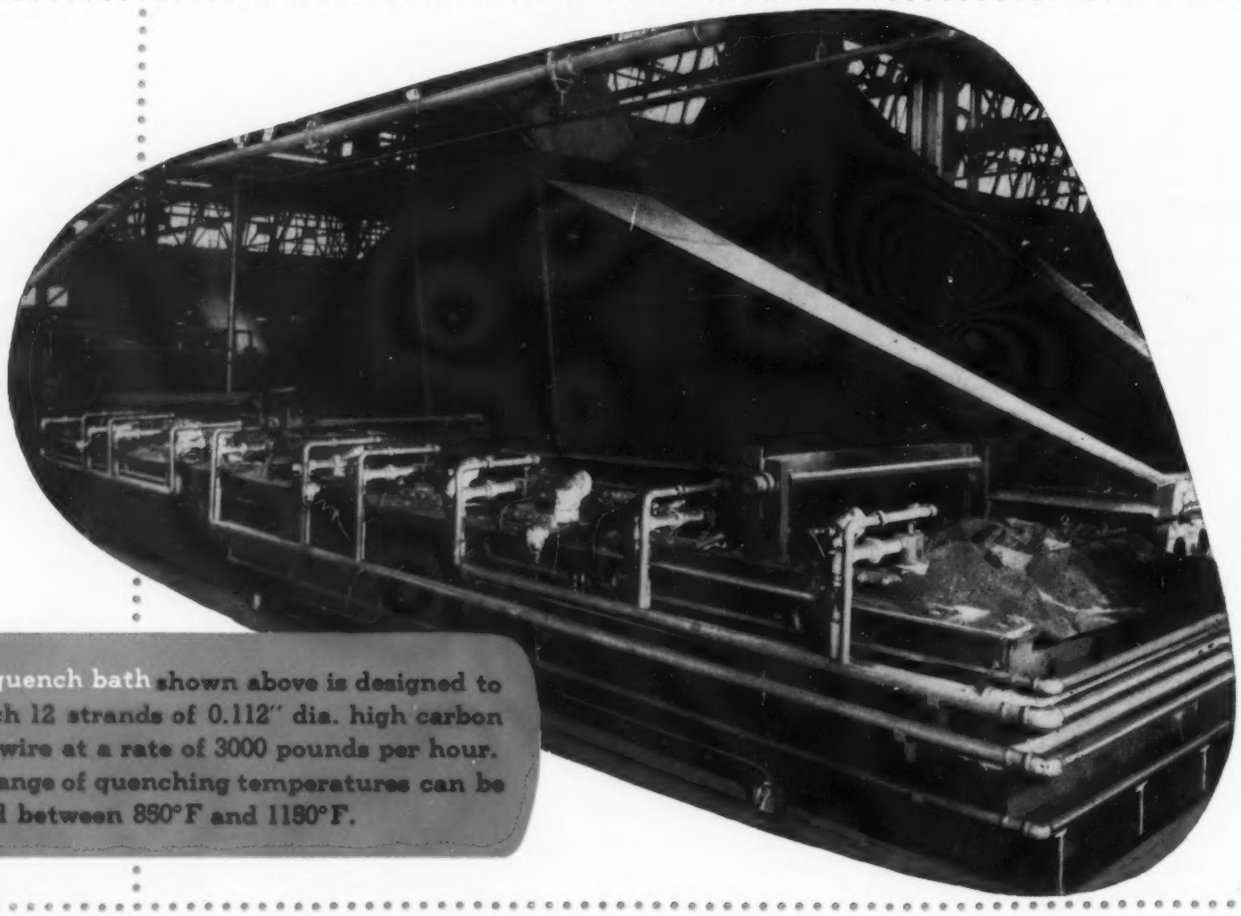
R. L. HOFFMAN

DREVER

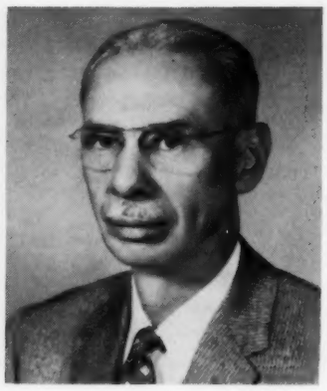
IMMERSION TUBE HEATED LEAD QUENCH FOR WIRE PATENTING

This 3-zone 30 ft. long gas-fired immersion tube heated lead quench forms part of a continuous patenting, cleaning and coating line for high carbon steel wires.

The multi-zoned lead quench is not only heated by gas-fired immersion tubes, but also utilizes the same immersion tubes with forced air cooling to maintain uniform temperatures throughout the bath. A specially designed control system automatically proportions the gas heating and/or air cooling of the tubes.



The quench bath shown above is designed to quench 12 strands of 0.112" dia. high carbon steel wire at a rate of 3000 pounds per hour. The range of quenching temperatures can be varied between 850°F and 1150°F.



STEPHEN DE COSTE (left)
W. L. TREADWELL (center)
C. B. JONES (right)

Stephen DeCoste has been appointed to a new assignment as supervisor of sales of plugs, receptacles and connectors, at Crouse-Hinds Co.'s headquarters office in Syracuse, N. Y. He was formerly with the company's New York office.

Walter L. Treadwell has been appointed industrial engineering manager of the Pacific Coast Engineering Co. Mr. Treadwell joined Paceco in 1951 as senior mechanical engineer.

C. B. Jones, former head of the Lewis Machine Co., was appointed by the Vaughn Machinery Co. to direct the development and marketing of a new line of wire straightening and cutting machines. Mr. Jones has been active in the wire machinery field for over 30 years. He operated his own sales company for many years, representing manufacturers of wire straightening and cutting machines, spring coiling and wire forming machines.

Allan Ray Putnam was appointed managing director of the American Society for Metals. Mr. Putnam will occupy a new position established by the ASM Board of Trustees following the death last May of **William H. Eisenman,** a founder-member of the Society and its national secretary and executive head for 40 years. Mr. Putnam comes to the American Society for Metals from Detroit where he was assistant executive secretary of the American Society of Tool Engineers.

David C. Skelly has been named manager of the Quality Control Laboratory at Harbison-Walker Refractories Co.'s Hays Works near Pittsburgh, Pa. Mr. Skelly has been a research engineer for Harbison-Walker since 1950.

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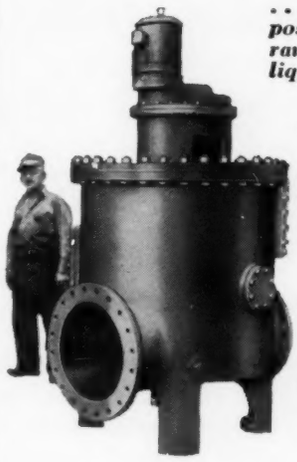

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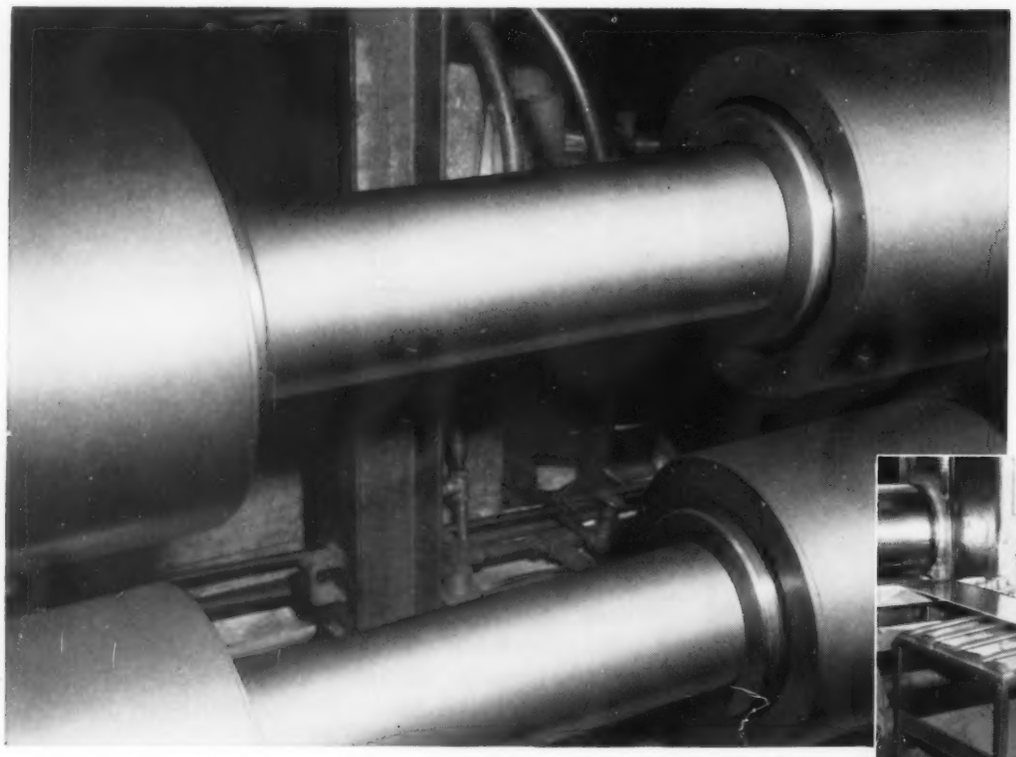
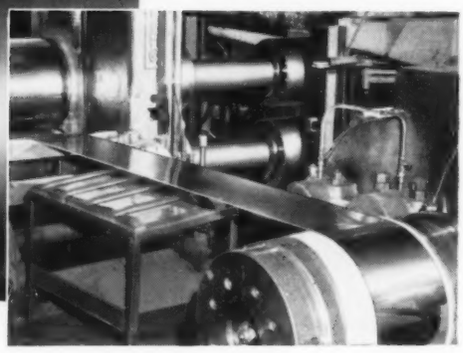


Close-up view of two AJAX Dihedral Spindle Couplings used on a modernized skin sheet mill. Each coupling has been operating at a torque of 50,000 Foot Pounds driving 20″ diameter rolls running at 15 to 40 RPM for

FOUR YEARS
with
MAINTENANCE
REDUCED TO ZERO

Lower photograph shows general view of installation.



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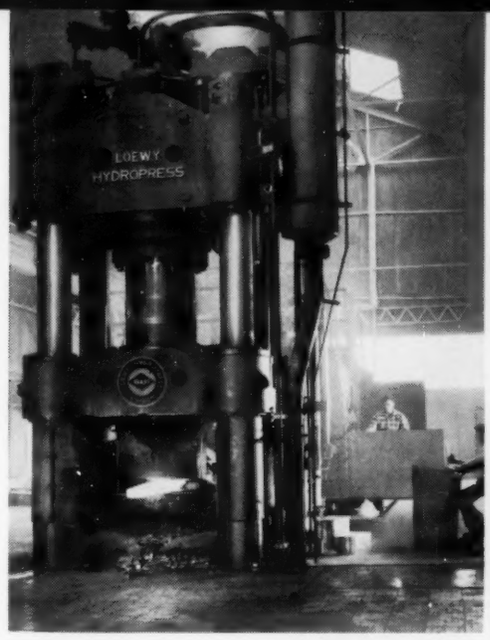
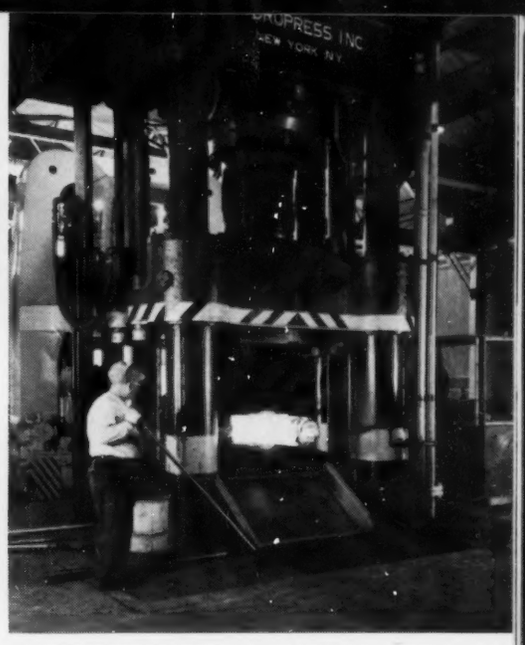
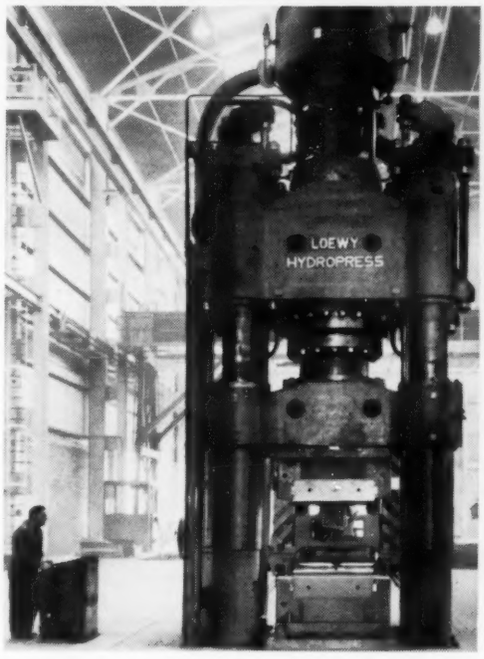


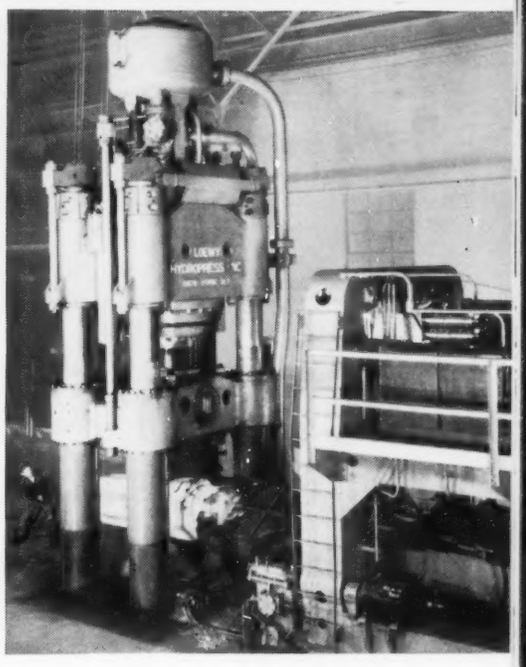
2000-ton press at Colonial Steel Division of Vanadium-Alloys Steel Co., Monaca, Pa. (left)



1500-ton press at leading alloy steel manufacturer in southern Pennsylvania.



2000-ton press at Simonds Saw & Steel Co., Lockport, N.Y. (left)



2000-ton press in operation at the Titusville, Pa., plant of Universal-Cyclops Steel Corp.

Why high-quality alloy steel makers are using Loewy fast-forging presses

The rapid advances in modern technology—especially in nucleonics, aviation and rocketry—call for production of the best in steels, free of segregation, clean and homogeneous, flawless and uniform in structure. Tests on high-quality steels produced on Loewy-Hydropress forging presses have yielded excellent results. America's leading mills find that Loewy forging presses enable them to meet the most exacting requirements of customers using steels for service conditions involving excessively high temperatures, stresses and corrosion.

Spontaneous statements by steel makers praise Loewy's "workmanship and fine talent," the trouble-free operation of Loewy forging presses, and the fact that these machines impart to special steels "internal qualities never before achieved." Again and again clients laud Loewy's continued and very real interest in their processes and operation, an interest which never ends with the installation of a press.

Loewy forging presses are designed for faster displacement of metal, fewer reheats, and minimum downtime. They outproduce hammers by a wide margin. Driven by air-loaded accumulators and equipped with oil-hydraulic servo controls, they assure smooth, safe, unfailing performance.

For particulars on how Loewy fast-forging presses can solve your production problems, write us at Dept. C-4.

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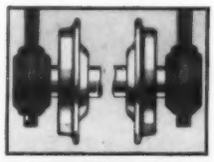
built to last by a company that uses them!

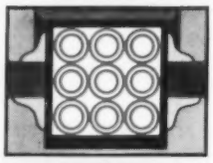
5 unique structural features make them better

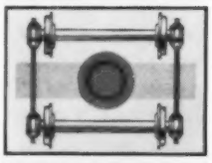
Ingot Mold Cars take more punishment than perhaps any other cars in a modern steel plant. In the 36 years we have been making these cars for our own use, United States Steel has developed a number of features in structural design that assure longer life, less maintenance, and dependable service.

Shown here is a typical 8-wheel, 200-ton capacity Ingot Mold Car. The advantages illustrated at the right—plus the rugged durability of all-welded rolled-steel construction—make any size USS Ingot Mold Car a profitable investment.

Our representative will be pleased to call at your convenience to discuss your requirements for this or any other type of industrial car. For more information, write to United States Steel, 525 William Penn Place, Pittsburgh 30, Pennsylvania. *USS is a registered trademark*







Anti-friction outboard bearings: High-capacity anti-friction bearings are located *outside* each of the car's eight wheels to minimize sidesway and to provide long, smooth-running performance.

Seventy-two coil springs: Nine coil springs between each two wheels on both sides of the car—plus nine overload coils *inside* these—provide a total of 72 separate springs for a shock-absorbed *level* ride, so important in hauling molten metal.

High engineering safety factor: Designed for a 200-ton normal capacity load—including ingots, molds and stools—each car has a substantial built-in safety factor to withstand maximum ingot-stripping thrusts.

Oversize center plates: "Beefed-up" center plates between the trucks and car body are 18 inches in diameter—compared with the conventional 12 inches—to reduce the load per square inch on their surfaces.

Hot-metal shields: Curved end plates, long side skirts, and special drip shields protect the couplers, bearings and springs from runover molten metal and troublesome solidified drippings.

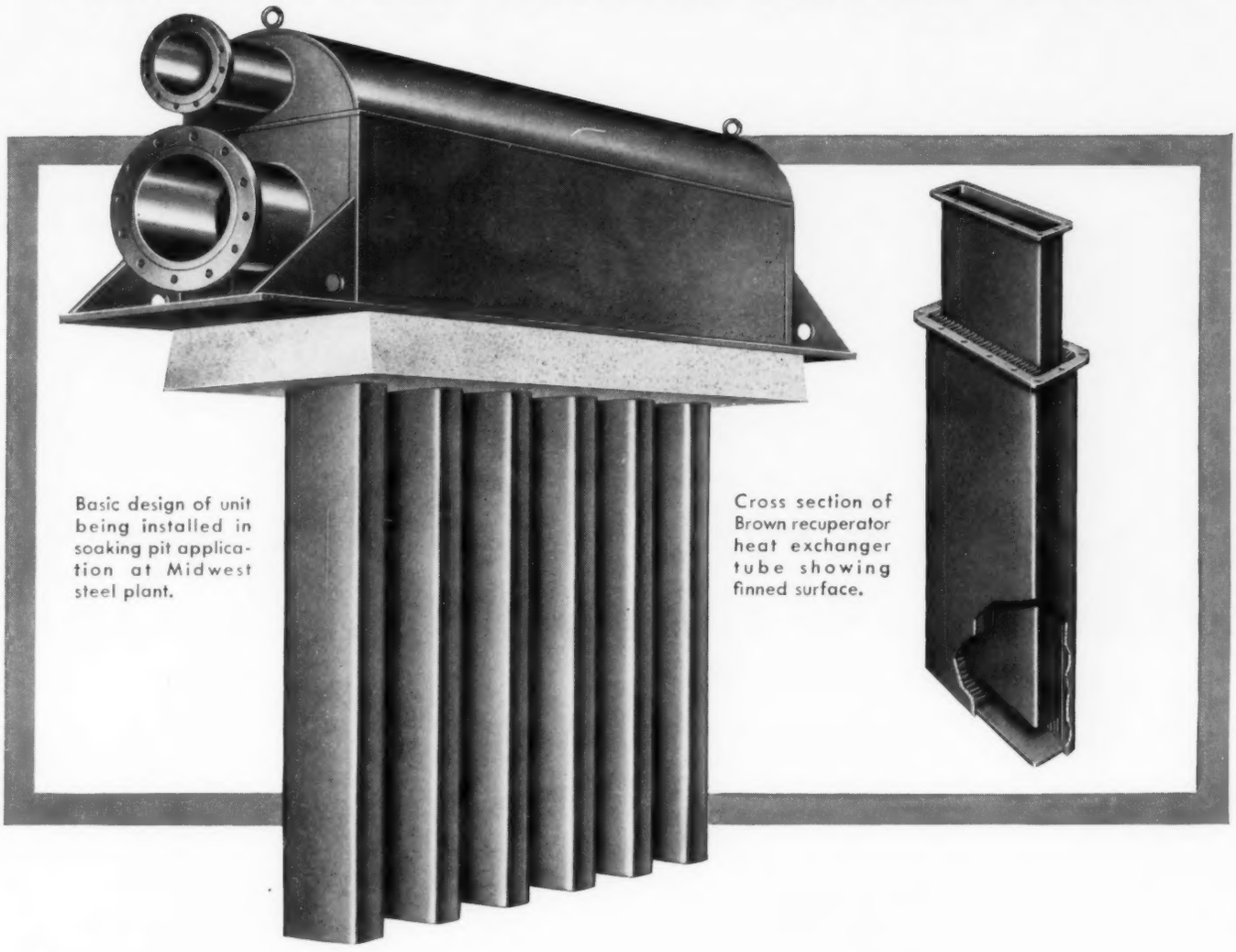
USS

United States Steel Corporation — Pittsburgh
Columbia-Geneva Steel — San Francisco
Tennessee Coal & Iron — Fairfield, Alabama
United States Steel Export Company

United States Steel

BROWN RECUPERATORS

Increase heat transfer surface 314%



Basic design of unit being installed in soaking pit application at Midwest steel plant.

Cross section of Brown recuperator heat exchanger tube showing finned surface.

- Brown fintube extended surface (up to 314%), made possible by use of fins integrally welded to the tube, acts to cool the outside tube wall, thus resulting in a low wall (metal) temperature during operation, which insures long life.
- Less floor space required, due to increased heat transfer with extended finned surface area.
- By suspending recuperator tubes from the top only, the expansion of metals is provided for and costly expansion joints are eliminated.
- Recuperators can be serviced during operation minimizing furnace downtime.
- Unit type construction offers quick replacement and application to all types of furnaces.
- All hot and cold air headers are furnished with circular standard flanges for connection to customers' air piping.
- Thermally engineered, designed and manufactured by heat transfer specialists serving major industries for 20 years.

HEAT EXCHANGE SURFACE

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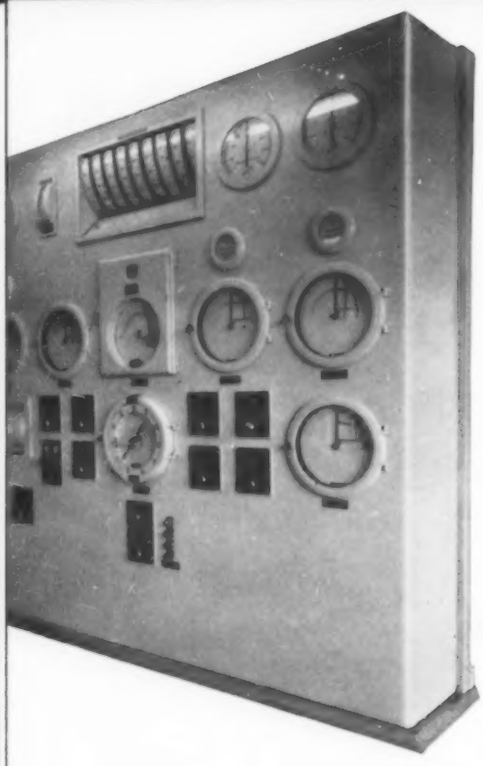
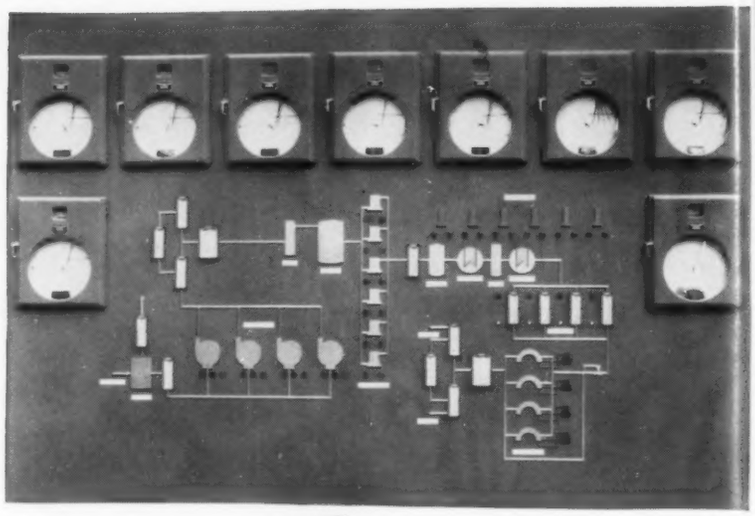
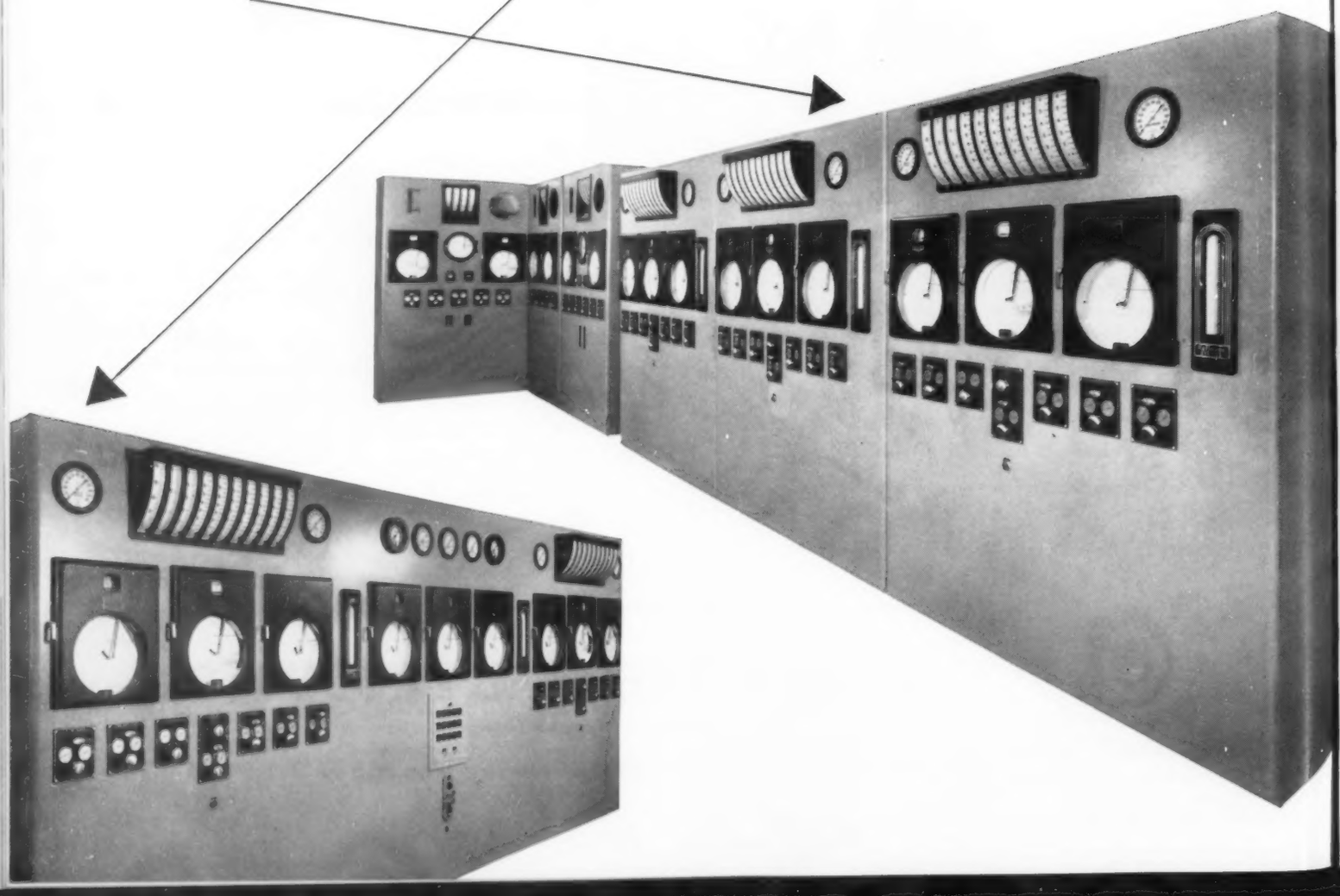
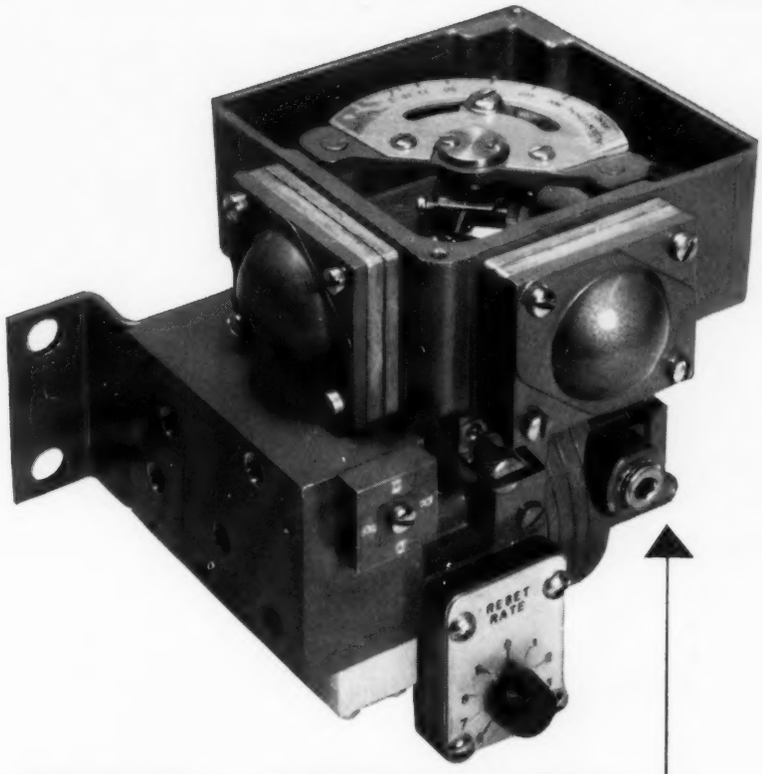




Base Any Of These.....





ON THIS

For accurate, efficient, dependable control systems— new Rockwell-Built REPUBLIC TYPE "VC" PNEUMATIC CONTROLLER

Here is an all purpose null-balance-vector controller for use with any pneumatic transmitter. Its proportional band ranges from 2% to 500% *without changing parts*, for quick adaptation to changes in process requirements. Especially important in high-precision control, Republic's Type VC has exceptional sensitivity and a narrow dead band (less than 0.05%). Its high capacity non-bleed pneumatic amplifier consumes little air, keeps output ample. A selector block permits reverse or direct action. Local or remote pneumatic set point optional.

Companion instruments—using an identical null-balance-vector "heart"—include differential pressure, temperature and pressure transmitters . . . ratio, totalizing, multiplying, squaring and square - root - extracting relays. Many parts are interchangeable among the instruments in this "family". Besides reducing spare parts inventory, the similarity of components simplifies the task of training personnel.

Let a Republic engineer show you how these instruments can help to achieve accurate, efficient, dependable control systems. Sales offices in principal cities throughout the U.S. and Canada. Write to Republic Flow Meters Company (subsidiary of Rockwell Manufacturing Company), 2240 Diversey Parkway, Chicago 47, Illinois. In Canada: Republic Flow Meters Canada, Ltd., Toronto.

REPUBLIC INSTRUMENTS AND CONTROLS
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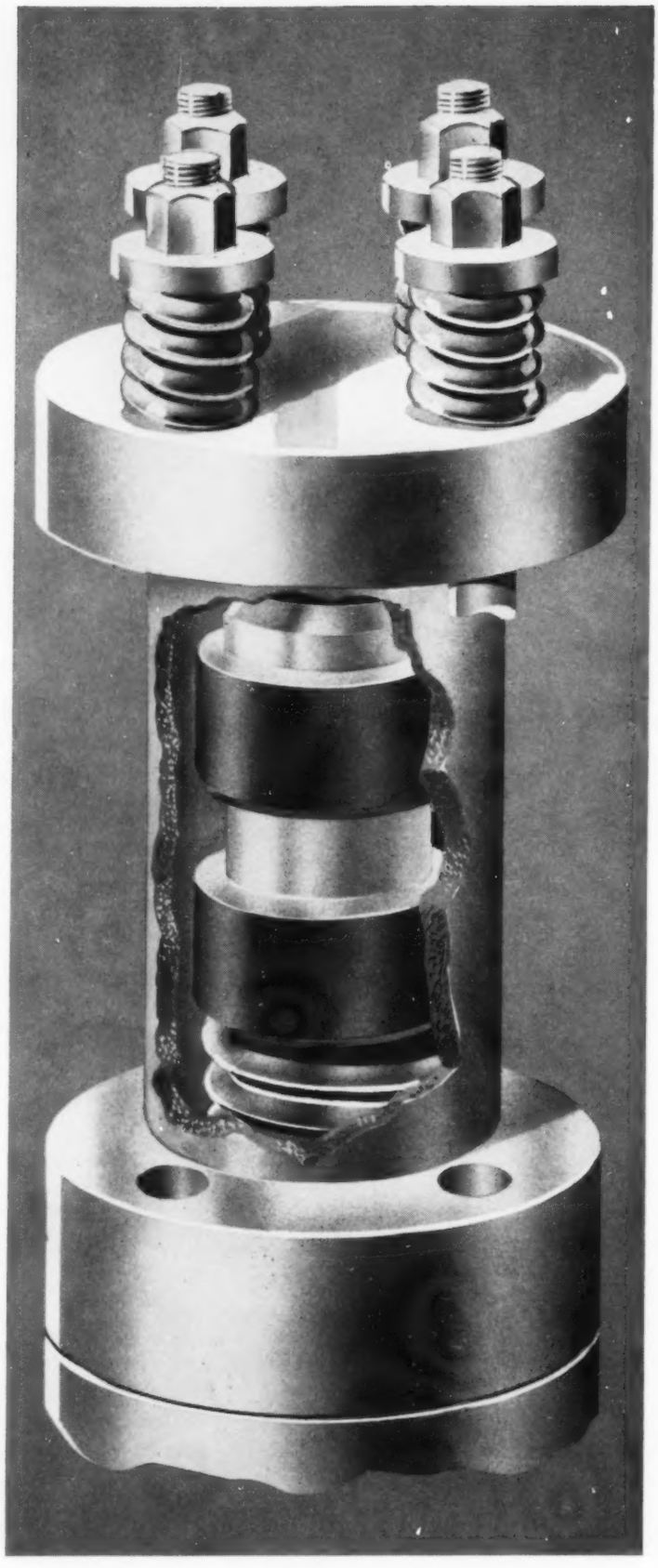
by bringing you lower precipitator maintenance and operating costs with

K-30*

bonded pistons on pneumatic vibrators



By eliminating the need for lubrication of the rapping mechanism in electrostatic precipitators, Koppers saves you many operational man-hours and maintenance costs.

This lubrication-free operation results from bonding a new wear-resistant material to vibrator piston surfaces. This special self-lubricating compound, identified by Koppers as "K-30," is composed of Teflon† and other wear-resistant materials that together provide a self-lubricated surface.

Most rapping mechanisms demand regular maintenance to be trouble-free, but "K-30" eliminates this need and provides more reliable operation.

Koppers research, backed by many years of experience in the electrostatic precipitation field will help you find the answer to your gas cleaning problems. Check with Koppers to learn how "K-30" can develop top efficiency in present or planned precipitator installations. For more information, write: KOPPERS COMPANY, INC., 6804 Scott Street, Baltimore 3, Maryland.

*Koppers Trademark

†E. I. duPont de Nemours & Company, Inc. trademark for tetrafluoroethylene resin

KOPPERS

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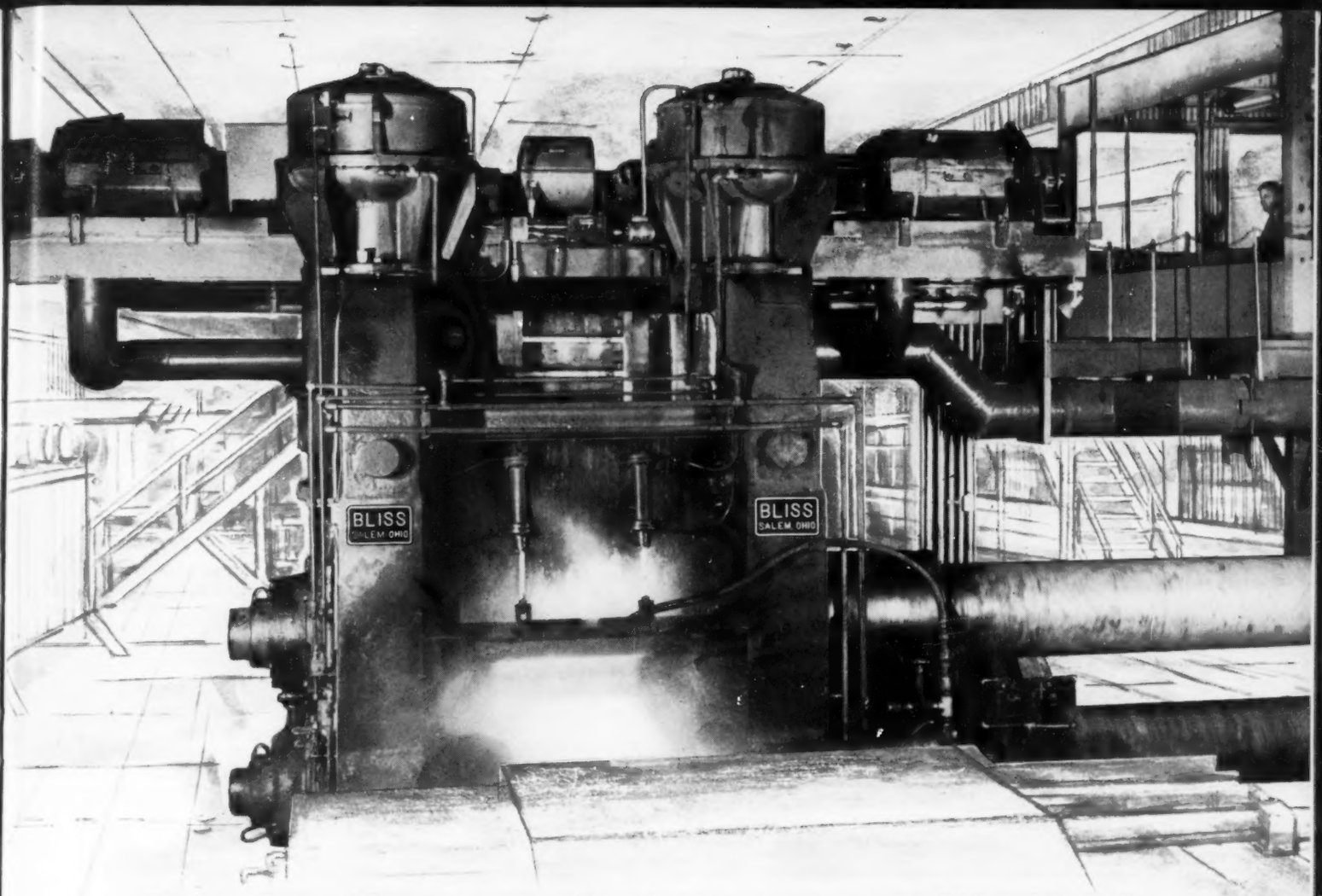

Empire-Reeves changes one mill stand, gains 85% boost in hot strip capacity

The famous hot strip line at the Mansfield, Ohio plant of Empire-Reeves Steel Corporation... the first mill in the world to roll fine-gage strip from ingot in a straight line without a reheat... has just had its capacity practically doubled by replacing a three-high one-way intermediate roughing mill with the new Bliss 38" x 52" reversing mill shown here.

Before the addition, the line averaged fifteen 4-to-5-ton ingots per hour. With the new Bliss mill, capacity ranges to 28 to 30 ingots per hour. Five-inch slab coming from the slabbing mill at the head of the line is reduced to ½-inch, where formerly the slabber had to roll the ingot into ¾-inch slab before the single pass through the old intermediate rougher.

Efficiency of the new mill is further enhanced by the use of a control system that automatically resets the mill between passes at the touch of a button.

Besides the new mill, Bliss' Rolling Mill Division built and installed a new shear that crops the strip ends before the strip enters the finishing train, and provided the new expanding-mandrel type downcoiler at the end of the line.

Whether you're interested in a single mill or a complete rolling plant, you'll find that the Bliss Rolling Mill Division will bring a sharp insight to your special rolling problem . . . an insight that can translate mill design and layout into striking new economy and efficiency. For examples of its work, write today for a free copy of the new 84-page Bliss Rolling Mill Brochure, Catalog 40-B.

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Subsidiary: The Matteson Equipment Company, Inc., Poland, Ohio

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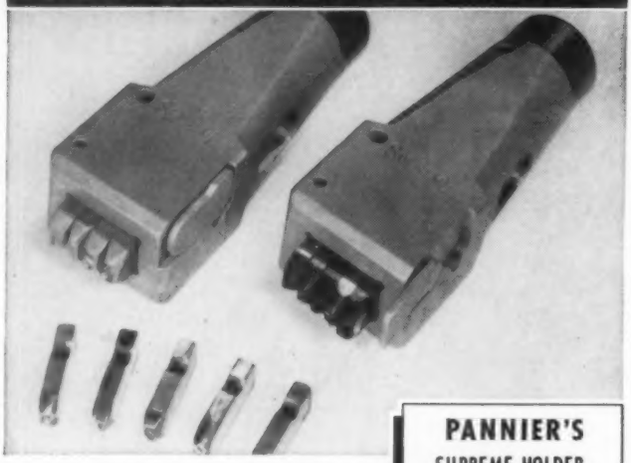

New Roto-Pin type lock is integral part of *all* Pannier Supreme Holders ... eliminates loose, bent, dropped, or lost pins ... flip it open to change type ... flip it back to securely lock type in clear-marking position.

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SUPREME HOLDER
WITH ROTO-PIN LOCK

Safe, fast type changing. Holder in variety of styles.
Machined from High-Grade Bar Tool Steel.
Hardened anvil maintains type alignment.
Striking Head of Tool Steel ... Replaceable to add long service life to Holder.

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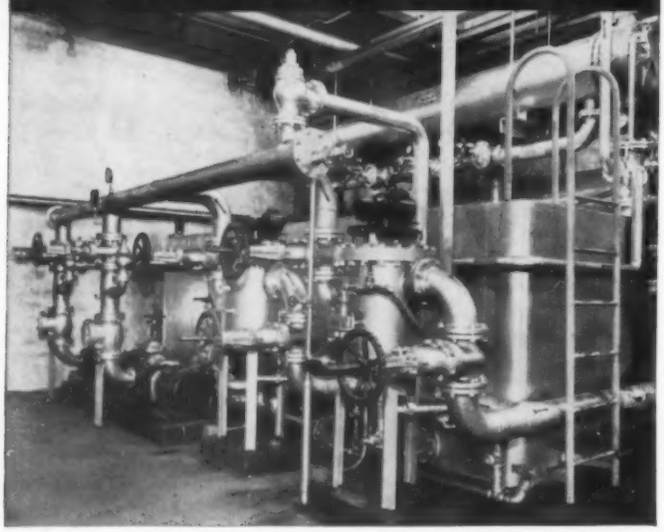
lubrication and coolant systems

Engineered Protection for Rolling Mill Machinery



Dravo-DeLaval Lubrication and Coolant systems are designed to circulate the right amount of lubricant at the right pressure and temperature to the right spot. Dravo Lubrication systems include these four fundamentals essential to efficient mill lubrication:

Streamline Flow

Piping, elbows and valves are carefully selected to hold pressure drops to a minimum and to provide non-turbulent flow.

Correct Metering of Lubricant

Dravo systems are designed to supply the right amount of lubricant needed at each lubrication point.

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Accurate, automatic temperature control is a feature of every Dravo system.

Efficient Filtering

Full flow, pressure type filters allow an uninterrupted flow of clean lubricant with minimum pressure drop.

Dravo-DeLaval systems are custom designed to match customer requirements. For installations requiring up to 50 gpm, Dravo-DeLaval Unilube units offer compact, economical "packaged" lubrication systems. For complete details, write Dravo Corporation, Dravo Building, Pittsburgh 22, Pennsylvania.

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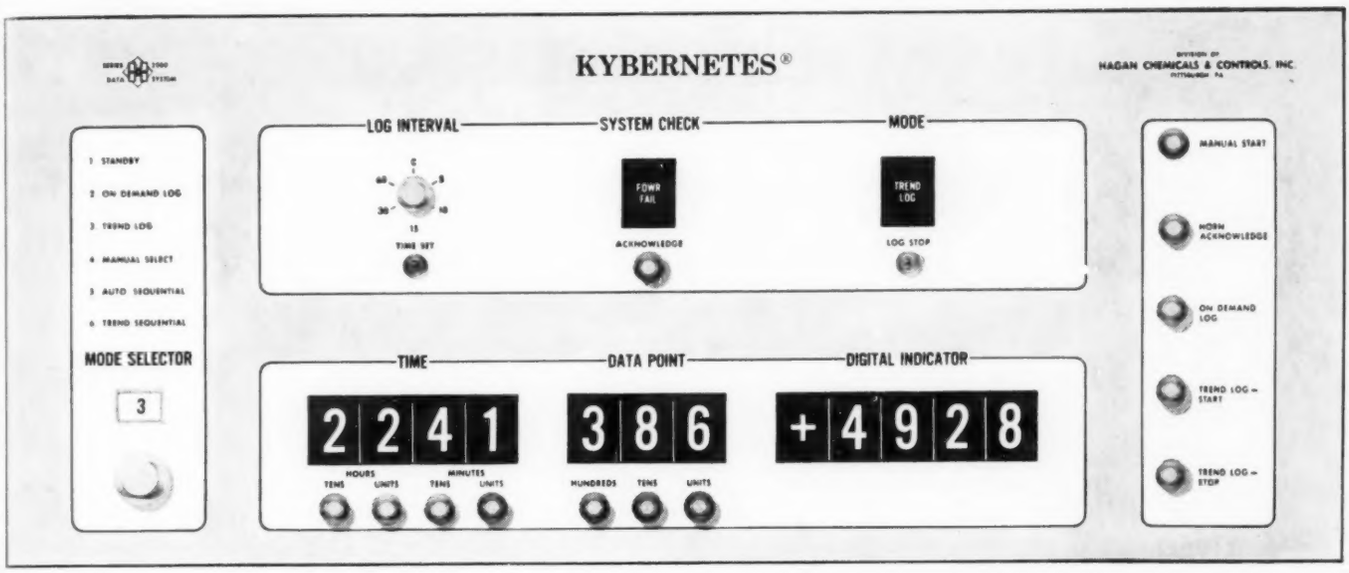
COMPLETELY NEW



Kybernetes Series 2000 Data Processing System

The new Kybernetes Series 2000 Data Processing System, utilizing solid state components, adds many data handling advances to the outstanding features of the original equipment. Here are some of the features the new Kybernetes system has to offer:

NEW FLEXIBILITY—Basic unit is a simple logging unit for recording process data on a log sheet or other output device. This basic system can be expanded easily, both in terms of the number of points scanned, and the complexity of the operations performed by the unit. For example these can be added as need develops: *Scanning for off-normal conditions—Printed or visual trend of selected variables—Computing and integrating—Automatic programming and optimum setting of control.*

NOTE—*Any* or *all* of these functions may be performed without interrupting any of the other functions. Off-normal scanning *always* proceeds uninterrupted.

OPTIMUM RELIABILITY—Fewer components, simplified design logic and solid state components add to the inherent reliability of the system. All parts have been selected for long life and easy maintenance.

MODULAR CONSTRUCTION simplifies extension of system. Each new function can be added by simply plugging-in appropriate module.

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ACCURACY of 0.1% on all inputs, including non-linear types is achieved by eliminating marginal techniques and components, using the highest quality components and by the use of simplified design logic.

Flexible, accurate and reliable, the new Kybernetes Series 2000 Data Processing System offers many previously unattainable advantages. Designed for maximum usefulness with minimum investment, *the new Kybernetes system permits the addition of functions as needed, including complete computer control.* A new brochure describes these advantages in detail. Write today for your copy; ask for Bulletin MSP-161.

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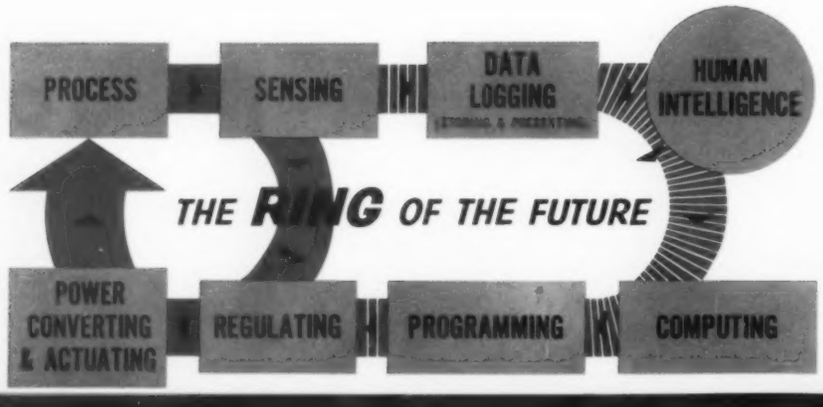

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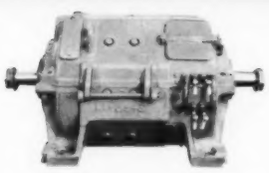

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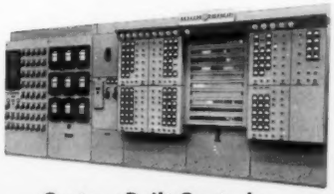
Main Drive D-c Motors



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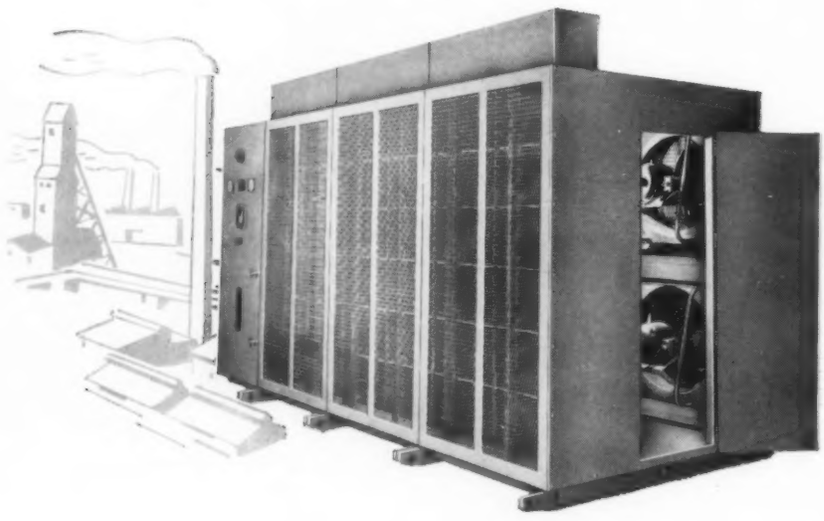

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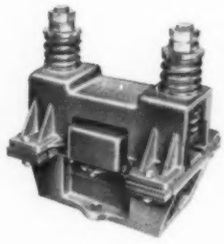

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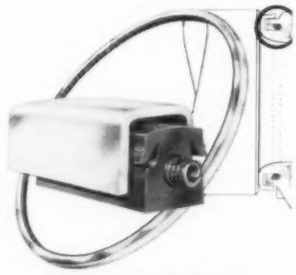

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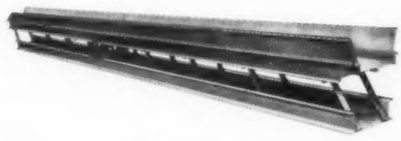

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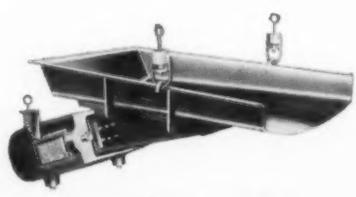

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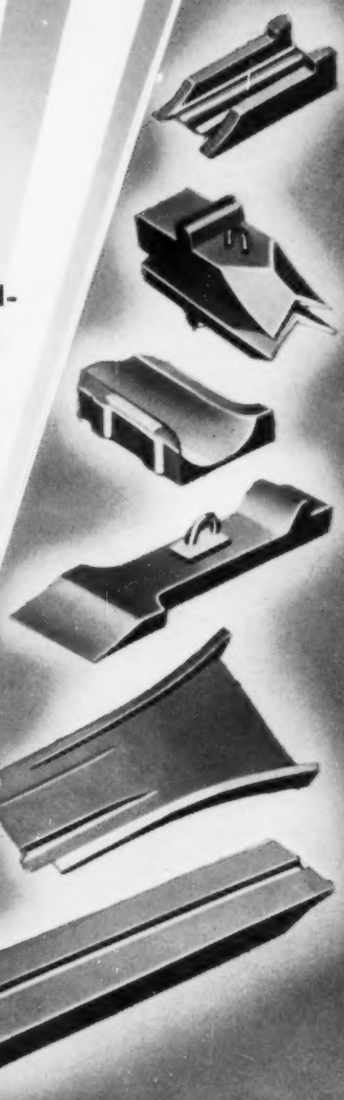
"TRANTINYL" offers a quarter-century of metallurgical experience. "TRANTINYL" patented alloys were developed to function in specific operations where guides are required to resist wear and abrasion. Users of "TRANTINYL" alloys are astounded at the tonnage rolled over one set of guides.

Join the many satisfied users of "TRANTINYL."



ROLLING MILLS:
bar, hoop, strip, shape mill guides; and rollers.

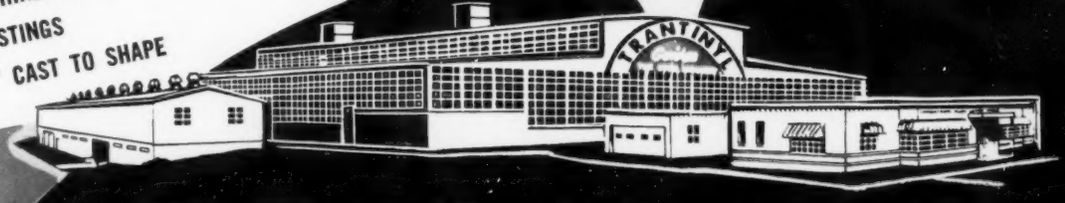
SEAMLESS TUBE MILLS:
guide shoes, rolling mill plugs and rolls, piercer points, etc.

ELECTRIC WELD TUBE MILL:
forming rolls, planishing rolls, tool holders, etc.

STRAIGHTENING MACHINE GUIDES

HEAT RESISTING CASTINGS

"TRANTINYL No. 1" CAST TO SHAPE



Youngstown Alloy Casting Corporation

Youngstown, Ohio

TRABON

CENTRALIZED LUBRICATING SYSTEMS

Make more profit per stamping with Trabon

Stop a press due to lack of lubrication and your cost per stamping soars! Add up the man hours it takes to lubricate a press by hand and it will stagger you. Yet, each time your press is down because of these reasons, you are losing money.

That's why manufacturers and operators install Trabon on their presses. A Trabon Centralized Lubricating System delivers the **exact** amount of oil or grease to bearings wherever located. Trabon does this automatically or manually, for hydraulic, mechanical, electric motorized and pneumatic equipment. In this way, Trabon protects expensive bearings, eliminates downtime due to haphazard lubrication, saves lubricant. Be sure to install Trabon on your equipment — soon! You'll reap the benefits immediately!

Trabon

Trabon Engineering Corporation

28785 Aurora Road • Solon, Ohio

Centralized OIL AND GREASE SYSTEMS Microfilt CIRCULATING OIL SYSTEMS

"Whitened" Trabon pumps and feeder valves provide these Verson eccentric presses with the exact amount of lubricant needed. Note the centralized warning-light system facing the operator, a standard Trabon feature.

Equipment News...

MAGNETIC CLUTCH

△ A novel stationary-field magnetic clutch, which virtually eliminates the need for maintenance in machine transmissions, has been added to the line of Electro Clutches made by the I-T-E Circuit Breaker Co.

The new clutches also permit reductions in the size of machine tool transmissions because they provide more torque for their size than any other units commercially available.

These clutches can be buried in a machine drive box or transmission because there are no air gap adjustments to be made, no slip rings and brushes to be cleaned, adjusted or replaced.

The new design, incorporating a closed flux path through hardened steel laminations, eliminates the need for adjusting air gaps. Use of a stationary magnetic field—coil windings are on the stator instead of on the rotor—eliminates slip rings and brushes.

Developed after more than three years of experimentation with 27 different designs, the clutches provide a new concept in trouble-free, dependable control for virtually any type of transmission requiring clutches.

The largest immediate market for the clutches is in the machine tool field, for such jobs as speed-changing, feed drives, brakes and couplings in drive systems of lathes, boring mills, planers, milling machines and grinders.

However, these new clutches open up many new possibilities for use in drive systems of rolling mills.

The new clutch series, designated EC-S, includes five sizes with torque ratings ranging from 14 through 290 lb-ft. The series will be expanded to include a total of 12 ratings by mid-1959.

A primary advantage of the new clutch is single-unit construction. Simplifying machine assembly, it permits fast installation. The stationary portion of the clutch is secured from rotation by a single threaded rod which screws into a tapped hole in the magnet body.

The new clutches offer other outstanding design, construction and performance features:

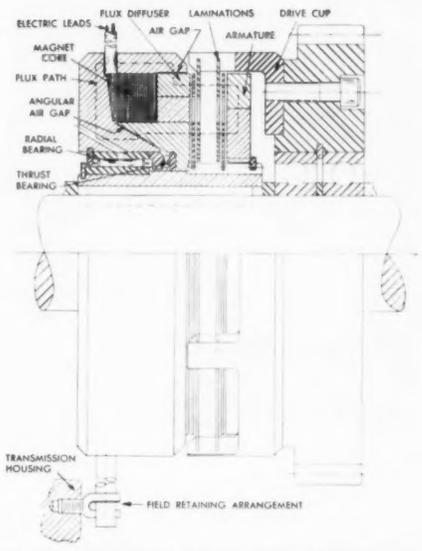
1. Unique, long-life bearing design.
2. Low-inertia design for minimum flywheel effect.
3. Multiple control voltages available.
4. Ease of adaptability through use of an external drive cup.

Much of the new clutch design evolves from the special consideration given to thrust loads. The company designed a longer air-gap—shaped like a cone—which was oriented approximately 30 deg relative to the shaft axis. In so doing, thrust load on the roller thrust bearing was reduced appreciably by converting a portion of it to bear against a radial needle bearing.

Also, by enlarging the air-gap cross-sectional area, flux density across the gap was reduced. This, in turn, reduced the number of ampere-turns required to produce enough flux for proper pressure on laminations.

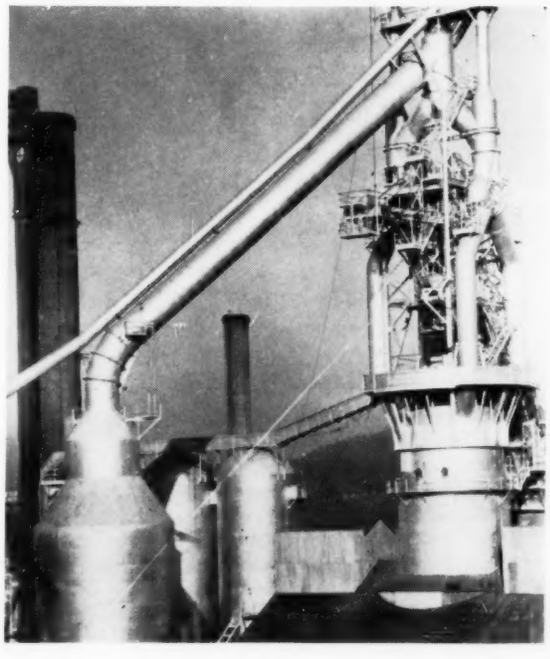
Open construction is another design feature of the clutch which provides a twofold advantage. Oil can enter around the radial bearing, and the angular-split air-gap acts like a pump to flush the bearing area and dissipate heat developed in the coil.

Rotating elements of the clutch have been kept to a minimum to



Construction details are shown in cross section which illustrates relationships of bearings and air gaps. Dashed line traces complete loop path of magnetic flux produced by stationary-field magnet.

BLAST FURNACE NOW IN OPERATION IN SPAIN



This new blast furnace, of Freyn-design, on which the engineering, procurement and supervision of erection was done by the Engineering and Construction Division of Koppers Co., Inc., is now in operation at the plant of the Empresa Nacional Siderurgica, S. A. (ENSIDESA), at Aviles, Spain. With a rated capacity of between 1660 and 1800 tons per day, the furnace has a hearth diameter of 28 ft, a working volume of 54,290 cu ft, and a height, from iron notch to top of hopper of 108 ft. In addition, Koppers is adding two open hearth furnaces of the stationary basic type, which, when completed, will have a 225 metric ton capacity.

HOW TO BEAT THE HEAT

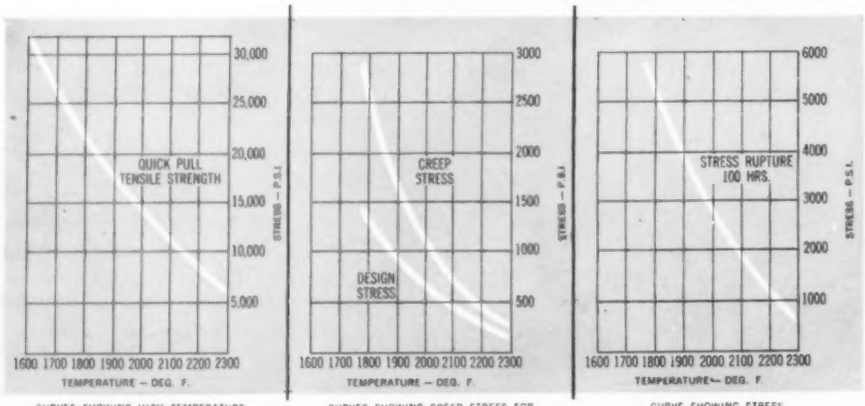
for strong high alloy requirements in the 1,800° to 2,300° F range!

DURALOY HOM*

*Covered by U.S. Patents

casting alloy

Duraloy "HOM" is a special high nickel alloy developed to produce castings that meet high temperature requirements, especially when castings are subject to oxidizing atmospheres.



CURVES SHOWING HIGH TEMPERATURE SHORT-TIME TENSILE STRENGTH OF DURALOY-HOM

CURVES SHOWING CREEP STRESS FOR CREEP RATE OF 1% IN 10,000 HOURS AND RECOMMENDED DESIGN STRESS FOR DURALOY-HOM

CURVE SHOWING STRESS TO RUPTURE AT 100 HOURS FOR DURALOY-HOM

Castings of DURALOY "HOM" are now being produced by our three methods: static, centrifugal and shell molded. Write today for additional information on this versatile new alloy.

The DURALOY Company
OFFICE AND PLANT: Scottdale, Pa.
EASTERN OFFICE: 12 East 41st Street, New York 17, N. Y.
ATLANTA OFFICE: 76—4th Street, N.W.
CHICAGO OFFICE: 332 South Michigan Avenue
DETROIT OFFICE: 23906 Woodward Avenue, Pleasant Ridge, Mich.

reduce over-all inertia so that flywheel effect of the clutch on the transmission is negligible.

All stationary-field clutches in a drive system can be connected electrically at a central terminal block. Each clutch receives power through a 30-in., 18-gage stranded neoprene-coated wire connected to the magnet body. Electrical connections can be made to conform to JIC specifications.

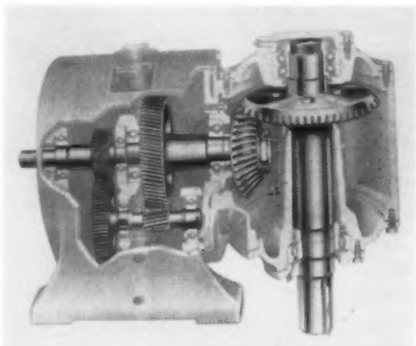
Clutches are available from stock for standard 24- or 90-volt direct-current operation. Other control voltages can be provided on special request.

RIGHT ANGLE HEAD

△ Western Gear Corp.'s Industrial Products Division announces availability of a universal-mounted right angle head adaptable for use on the company's StraitLine speed reducers and gearmotors.

The right angle attachment can be furnished in horizontal, vertical or intermediate positions with single or double extended shafts. It features spiral bevel gearing precision cut from alloy steel forgings and case hardened for maximum strength and durability. Each set of gears is matched and lapped after hardening to insure precise contact and quiet operation.

Conservatively selected bearings, husky output shaft and a wide bearing span provide ample overhung load capacity for chain, pinion and belt service.



Other features include:

1. Dry-well construction to prevent oil leakage down the output shaft when the unit is vertically mounted.

2. A simple splash lubrication system, integral with the main housing, provides thorough positive lubrication of gears and bearings. Case design allows oil to be circulated freely at all times.

another proven ECONOMY performance by RICHARDSON-ALLEN

SILICON RECTIFIERS

500 KW RECTIFIER INSTALLATION CHALKS UP SAVINGS IN MONEY...SPACE...PERSONNEL

UNITED STATES ENVELOPE COMPANY's Kellog Division in Springfield, Massachusetts, recently completed installation of four versatile Richardson-Allen rectifiers Model S1FAB120/240520C. Designed and manufactured in four separate units capable of operating independently or in parallel, the new installation offers exceptional flexibility and compactness. Units may be used separately to provide the emergency power so often needed in other plant areas, or other plants. They may be combined two, three, four or more units at a time and new units may be added at will.

UNITED STATES ENVELOPE COMPANY reports savings of up to $100 per day over the cost of fuel previously used for production or power by steam-driven generator. Personnel was freed for service elsewhere in the plant and it became possible to clear much-needed space for compressor installation. Power losses at the Springfield plant were cut substantially since each of the four rectifiers Model S1FAB120/240520C delivers power of maximum efficiency.

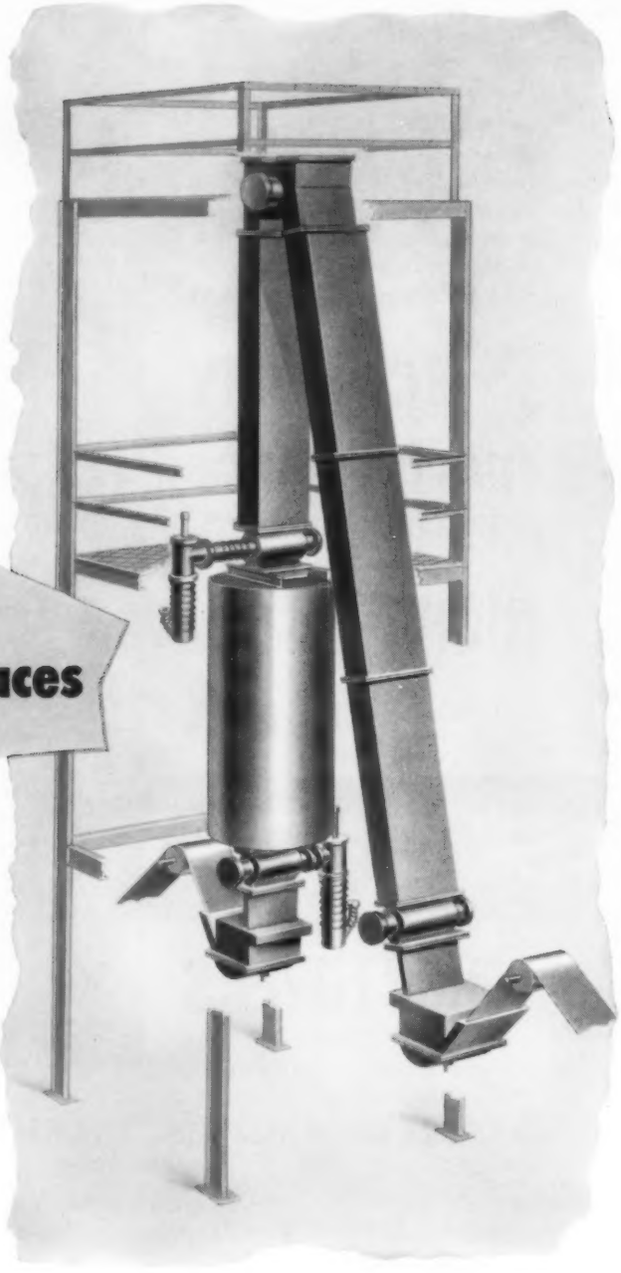
OPERATING COSTS GO DOWN—Economies effected by the Richardson-Allen installation for the United States Envelope Company are typical of the savings that their Silicon rectifiers have brought to plants across the country. Richardson-Allen is now supplying major industries with highly efficient DC power—without ageing and with no apparent limit to the life of the Silicon junctions.

RICHARDSON-ALLEN Corporation

Dependable Rectifier Specialists

116-15 FIFTEENTH AVENUE, COLLEGE POINT, L. I., N. Y.

Another **EF** *"first"*



Fuel-fired or electrically heated

Continuous Vacuum Furnaces

for bright heat treating of

Beryllium, Hafnium, Tantalum, Titanium, Zirconium, High Carbon Steels, 200—300—400 and Precipitation Hardening Stainless Steels

and other strip

Again Electric Furnace Co. research scores an important break-through in heat processing. Now, fully developed and ready for commercial service, these new EF continuous vacuum furnaces offer many advantages. This continuous vacuum treatment:—

1) Is chemically neutral to all metallic alloys. It avoids the possibility of gas pick-up by the material being treated, thus assuring no carburizing, no nitriding and no de-carburizing.

2) Improves the physical properties by "outgassing" the material.

3) Eliminates any hazard of explosion.

4) Drastically reduces the operating costs by eliminating the need for special atmosphere equipment.

Temperatures to 2100° F., higher if necessary. Strip can vary from .0005" to any coilable thickness, in any desired width. Furnished complete with vacuum pumps, automatic controls and terminal equipment if desired.

We will welcome an opportunity to discuss with you the advantages of this new, continuous vacuum process, and to quote on the equipment that will best meet your particular requirement.

EF

THE ELECTRIC FURNACE CO.

Gas-fired, Oil-fired and Electric Furnaces for Heat Treating any Product, Using any Process, any Hourly Output.

300 West Wilson Street *Salem - Ohio*

Branch Offices in Detroit, Mich., Santa Ana, Calif., and Cheshire, Conn. Canadian Associates, Canefco Limited, Toronto 13, Ontario

3. Less maintenance is required due to the fact that only two alemite fittings are required to lubricate bearings when the output shaft is in the vertical position. Large grease reservoirs are provided to insure positive lubrication.

WIRE STRAIGHTENER

△ The Vaughn Machinery Co. announces its entry into the field of wire straightening and cutting machinery by the introduction of the all-new Vaughn Motomatic No. 75.

The machine employs the caterpillar chain feed technique which provides positive feed, eliminates twist and speeds the entire coil through the machine, reducing scrap to a minimum. It includes a simplified flying shear cut-off synchronized with the wire feed and an electric variable speed drive, using a d-c motor or a-c variable speed unit, controlled by a single lever. These features provide fast, efficient delivery of uniform diameter and lengths of straight, precision-cut wire at variable speeds up to 300 fpm.

Designed to handle a wide range of wire sizes, the machine is equipped with an adjustable-center straightener arbor which permits increasing the size range of the machine up to 50 per cent. It is a completely self-contained, compact unit furnished with all electrical and mechanical parts, including a quick loading safety reel and an extension and run-out table of fabricated steel.

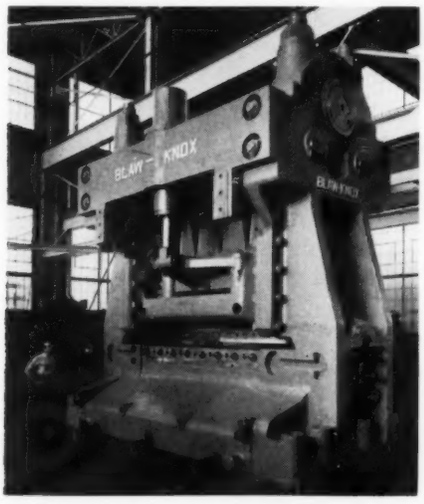
Other design features include gears, sprockets, feed and straightener rolls mounted on tapered bushings; feed roll pressure applied by air cylinders and controlled by pressure regulating valves; utilization of roller bearings on all feed and straightener shafts, main drive shafts and flywheel; and main drive units which consist of fully enclosed, self-lubricated worm gear reducers and a spiral bevel gear unit.

HIGH-VOLTAGE CUTOUT

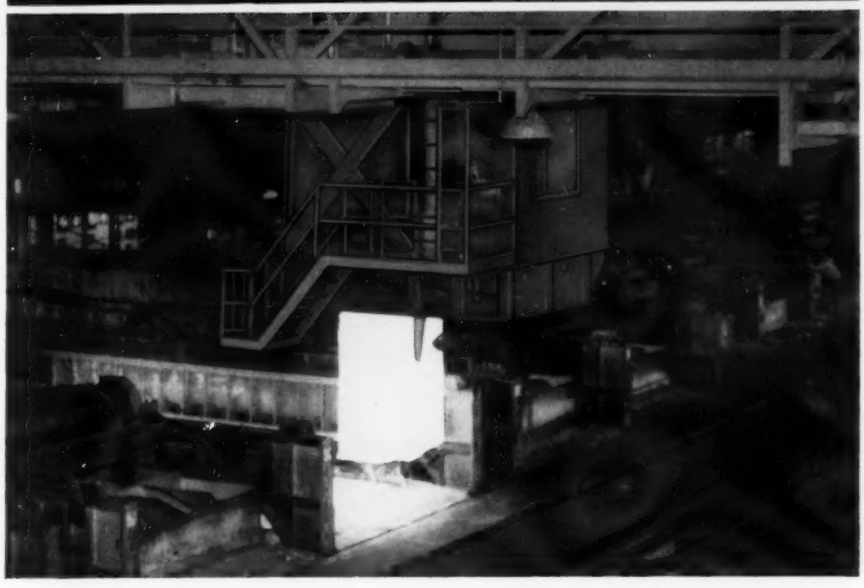
△ A new open cutout (Type CDX) for distribution system voltages of 14.4 kv to 24.9 kv and wye systems

SHEAR UNIT

Packing a knife pressure of 3,000,000 lbs, this combination bloom, slab and plate shear was built by Blaw-Knox Co. for Algoma Steel Corp. Described as the downcut, start and stop type, the motor-operated shear will cut blooms up to 14 × 14 in., slabs 60 in. × 8 in., and plate up to 108 in. maximum width. The shear unit when installed will include a shear depressing and pullback table, a motor-operated shear gage, crop pusher, chute and hoist.



Although exposed to high ambient temperatures, this cab is easily kept at 80°-85° F. It means safer and better working conditions and improved production.



Hot enough to cook a crane operator

BUT IT DOESN'T HAPPEN HERE!

The man inside this crane cab is fresh and efficient because his cab is Lintern Air Conditioned. In spite of that hot ingot, the operator enjoys a comfortable temperature the year around. He's free of fumes, gases, dirt and the fatigue that excessive heat brings on.

Thanks to **LINTERN AIR CONDITIONING**

hundreds of plants have improved efficiency. Right now Lintern is busy modernizing the crane cabs and pulpits of dozens of plants. This means they'll enjoy more output, less labor turnover, a greater return on their capital investment.

Maybe you should do this, too. It costs nothing to find out.

Write for Bulletin AC-573.

Larco, inc.
DISTRIBUTOR OF LINTERN CORPORATION PRODUCTS
ROUTE 20 EAST • PAINESVILLE, OHIO

up to 34.5 kv is available from the Westinghouse Electric Corp.

A nonferrous, single-insulator, crossarm mounting type, the new cutout is supplied with a solid cap on the fuseholder and interrupts 2000 amp. With an expendable cap on the fuseholder, the unit interrupts 6000 amp. Both the standard fuseholder and the loadbreak fuseholder are available.

Completely "birdproof," a polyethylene coating on the metal clamps that hold the unit to the porcelain insulator eliminates short circuits of either natural or bird origin.

The new cutout accommodates wire size up to 1/0 stranded ACSR and meets all EEI-NEMA industry standards for 27-kv open cutouts.

LIFTING TONGS

△ A new automatic materials handling tong, called the American Cranehand, that lifts and deposits steel sheet piling within limited or crowded stock areas, has been designed, engineered and built by American Forge & Manufacturing Co.

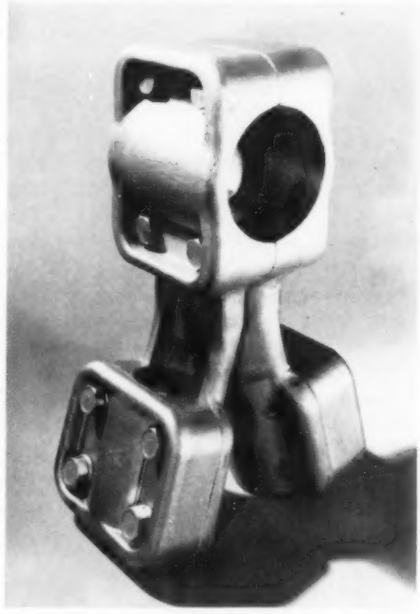
Made of heat-treated alloy steel, the device weighs 125 lb and has a capacity of 2000 lb. It handles three different piling shapes, USS Nos. MP112, MP115 and MP116 or equal, in bay areas with as little as six inches space leeway. The hook takes on single length piling up to 60 ft.

The tong connects with or "grabs" the center of the piling when lowered in its locked position. Resting on the piling, it unlocks automatically. In its unlocked position, the tong grips the load securely—the heavier the load, the tighter the grip. After a piece of piling is lifted and deposited, the tong automatically completes its cycle to its "locked-open" position, ready for the next lift.

CONNECTORS

△ Delta-Star Electric Division, H. K. Porter Co., Inc., has developed a new line of power connectors for voltages above 161 kv, designed to assure corona-free service.

Features of this new line of extra high voltage connectors include

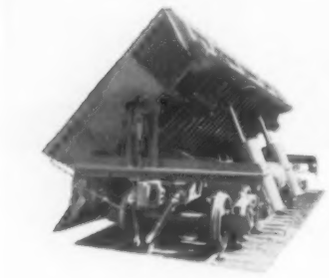


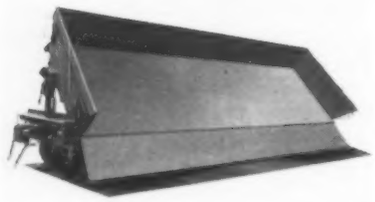
recessed bolt heads, tapped holes eliminating nuts and protruding bolt ends, perfectly rounded corners and edges of all castings, and generously proportioned cross sections with no sharp contour changes.

Available at present in several sizes of the standard Tee connectors in both bronze and aluminum, the new line will be expanded continuously as more and more utilities increase the transmission voltage of

DESIGNED

FOR THE JOB—BUILT TO LAST!





Magor heavy duty air dump cars are designed to do just one job—speed-up waste disposal. Low height and greater size means faster loading—fewer trips. Automatic dumping eliminates expensive labor and crane equipment. Smooth car interiors eliminate "dead load" returns.

Made for the job, Magor Air Dump cars can cut your disposal costs as much as 40%! And because they're made to last, your maintenance costs will be cut too! Tapered body ends and double plate construction across load carrying members, for example, adds strength and years of service.

Magor engineers are ready to show you how to cut today's high costs down to size.

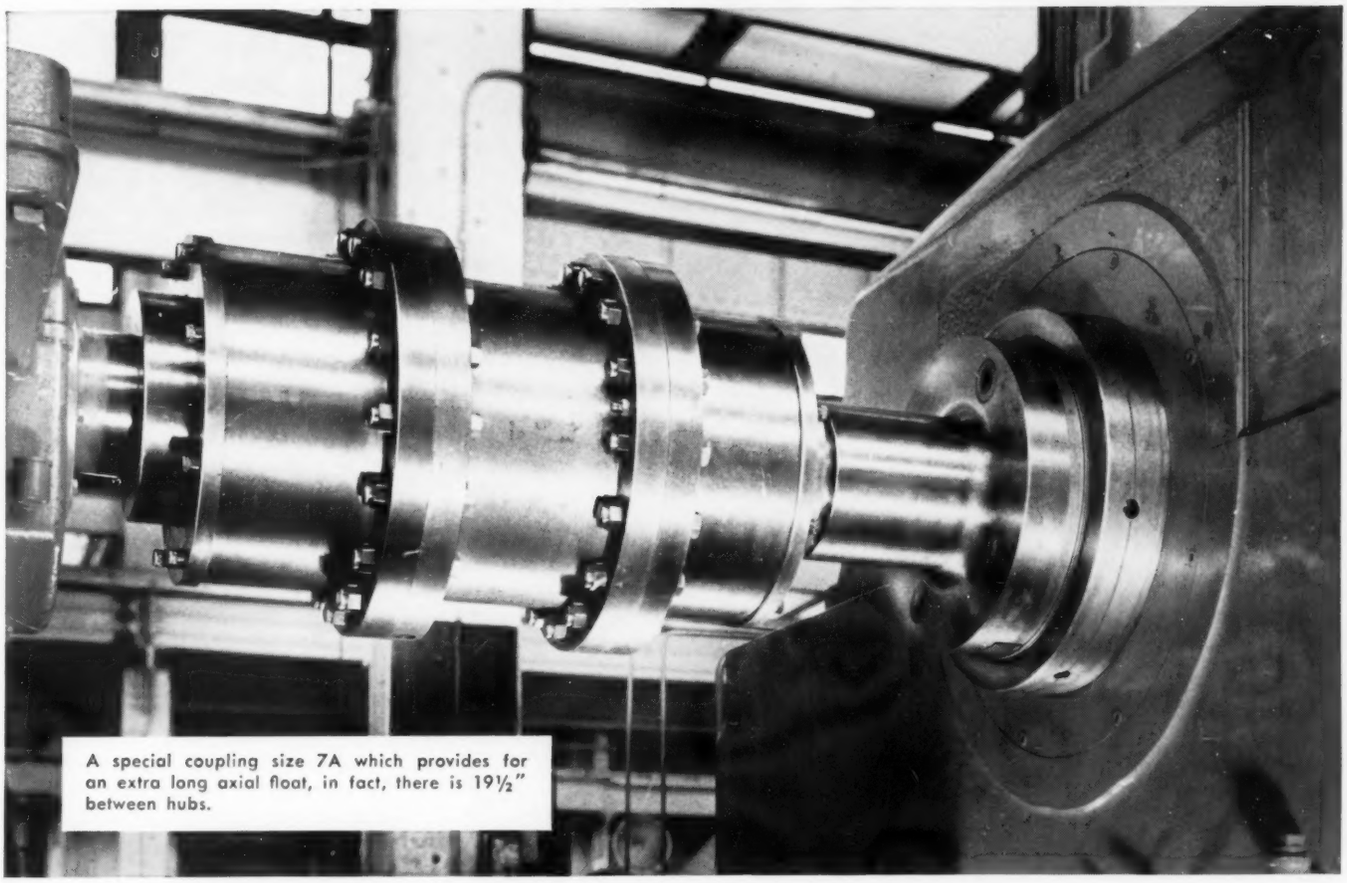
MAGOR

Write today for details and for the new folder describing the heavy duty air dump car.

MAGOR CAR CORPORATION

50 Church Street
New York 7, N.Y.

SPECIAL COUPLING PROBLEMS



A special coupling size 7A which provides for an extra long axial float, in fact, there is 19½" between hubs.

SOLVED

at JOHN WALDRON

From time to time, manufacturers are faced with special power transmission problems which cannot be handled by standard couplings. Sometimes they need a coupling for exceedingly high speed drives, sometimes a coupling for very large diameter shafts and for other special applications.

John Waldron, which is well known for its ability to produce high quality couplings also makes excellent special couplings to customer requirements. In the past, Waldron has made couplings that turn at speeds over 50,000 RPM, couplings which can take over 45,000 HP and couplings for particular applications such as continuous lubricated couplings, spacer types, shear pins, cut-outs and couplings for many other special installations.

If you have a particular power transmission problem that needs a special coupling, call or write the John Waldron Corporation in New Brunswick, New Jersey. Their long experience in designing, and manufacturing couplings for special problems, may have already solved your problem for you.

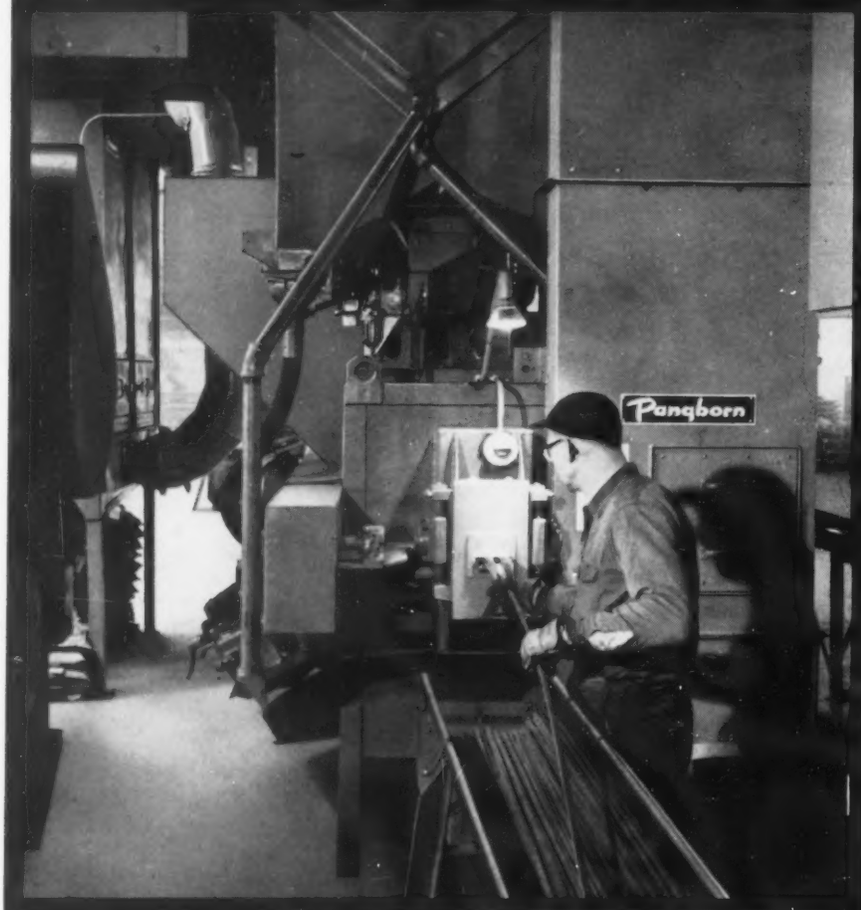
MR MIDLAND-ROSS CORP.

JOHN **WALDRON** CORP.

Subsidiary of Midland-Ross Corporation

New Brunswick, New Jersey

ROTOBLAST DESCALING SAVES $75 A DAY



Pangborn Rotoblast Descaling Machine makes cost-cutting automation possible at Bustin Steel

At Bustin Steel Co., Dover, N. J., hot rolled steel bars are descaled by a Pangborn Rotoblast Machine at rates up to 180 linear feet per minute. This speed of operation plus the perfect quality of work—eliminating oiling and degreasing operations later—permits inserting this Rotoblast Machine directly at the head of the production line, working toward a completely automatic manufacturing operation.

The operating cost of this machine saves Bustin at least $75 a day compared to pickling, *plus* the cost of degreasing *plus* savings resulting from longer tool and die life.

For information on how Pangborn Rotoblast can save *you* money, write PANGBORN CORP., 4400 Pangborn Blvd., Hagerstown, Md. *Manufacturers of Blast Cleaning and Dust Control Equipment and Rotoblast Steel Shot and Grit.*

Pangborn

CLEANS IT FAST WITH ROTOBLAST®

their systems and the need for corona-free design becomes widespread.

COMPUTER SYSTEM

△ A GE 309 gage logging system has recently been delivered and will soon be in operation at Inland Steel Co.'s Indiana Harbor Works.

The computer system operates in conjunction with an x-ray thickness gage which measures the thickness of the steel strip being rolled, and a mill tachometer which provides electrical pulses for indicating the number of feet of strip steel produced by the mill. An electronic unit classifies the thickness of the material, as it is measured by the gage, into several tolerance bands, such as "on gage," "bands ABC off-gage high" and "bands ABC off-gage low."

As the steel strip is being processed the system accumulates the required information. Upon completion of the strip, a complete record of the number of feet in the strip, the number of feet of "on gage" material, the number of feet of "off gage" material and strip identification data is transmitted by teletype to another location on the line where it is printed out for record purposes.

Designed primarily for steel mill use the GE 309 system is fully transistorized and sturdily constructed to provide high reliability in severe industrial environments.

AUTOMATIC FEEDERS

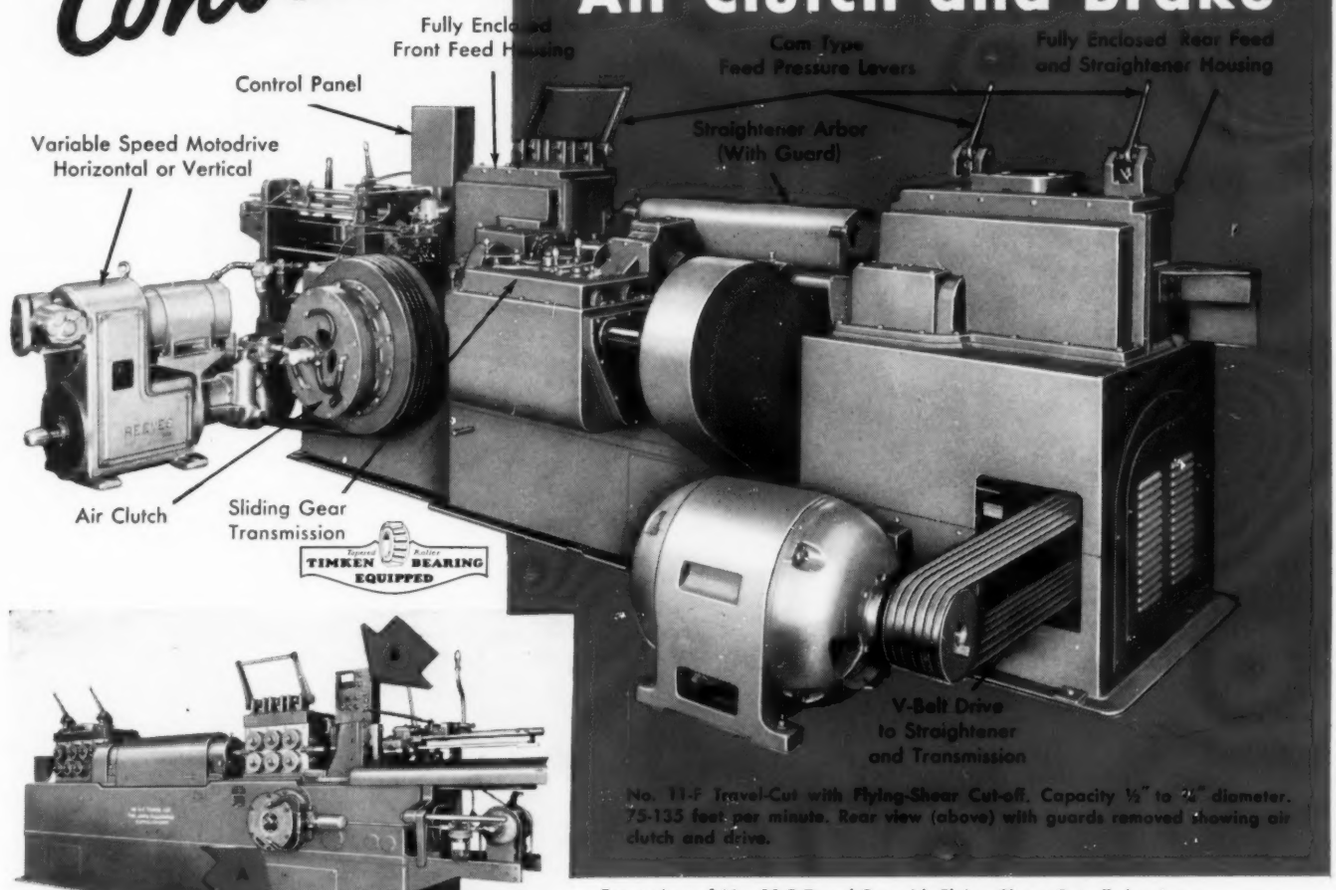
△ The Tennessee Coal & Iron Division of United States Steel Corp., Fairfield, Ala., is presently mechanizing the feeding of six slitters which trim tin and black plate. The company has installed five metal sheet feeders manufactured by The Dexter Co. Division of Miehle-Goss-Dexter, Inc., and will soon install a sixth to automatically feed the one remaining manually fed machine.

With automatic feeding, bundles weighing in the neighborhood of 3500 lb are brought to the feeder by an overhead crane and positioned on a stand-by conveyor for loading onto the feeder's elevator platform. When the preceding bundle has been fed off, the elevator platform is lowered, the empty pallet is removed

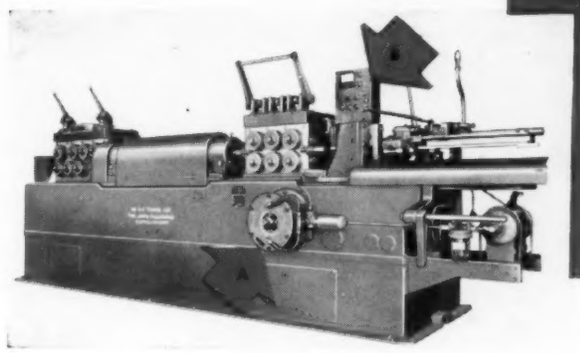
Better Quality Control *

LEWIS

Wire Straightening and Cutting Machines with Air Clutch and Brake


Fully Enclosed Front Feed Housing
Control Panel
Variable Speed Motodrive Horizontal or Vertical
Air Clutch
Sliding Gear Transmission
TIMKEN BEARING EQUIPPED
Com Type Feed Pressure Levers
Fully Enclosed Rear Feed and Straightener Housing
Straightener Arbor (With Guard)
V-Belt Drive to Straightener and Transmission

No. 11-F Travel-Cut with Flying-Shear Cut-off. Capacity ½" to ¾" diameter. 75-135 feet per minute. Rear view (above) with guards removed showing air clutch and drive.



Front view of No. 11-F Travel-Cut with Flying Shear Cut-off showing Air Brake "A" (with guard removed) and operating panel "B" with push-button controls for Air Clutch, Reeves Motodrive and flywheel speed Indicator Tachometer.

● Lewis engineers have added three important improvements to their famous Travel-Cut Machines for BETTER QUALITY CONTROL . . . These machines are already in service in America's leading steel and wire mills.

✳ Wichita Air Clutch permits higher cut-off speeds, eliminates shock of conventional clutch. No adjustment necessary . . . automatically compensates for wear.

✳ Wichita Air Brake eliminates conventional mechanical drag brake and is only engaged for a short portion of the cut-off cycle.

✳ Reeves Variable Speed Motodrive permits infinite adjustment of flywheel speed for perfect synchronization of the cut-off and wire feed speeds. This unique arrangement makes possible the cutting of rod WITHOUT SPOT SWELL . . . allows finer adjustment for cutting short lengths. Dial tachometer registers flywheel speed.

There are Standard Lewis Travel-Cut or Stationary-Cut Machines designed to straighten and cut all materials and shapes in wire or rod from .012" to 1" at a wide range of feed speeds.

Air Clutch available on all Travel-Cut Models. Send for new brochure showing complete line of Lewis Wire Straightening and Cutting Machines.

LEWIS MACHINE COMPANY 3440 East 76th Street Cleveland 27, Ohio

Now TM
Hammerlok
coupling links

assure SAME-DAY deliveries

on TM alloy sling chains
with patented
TAYCO HOOKS
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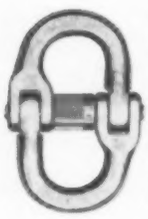

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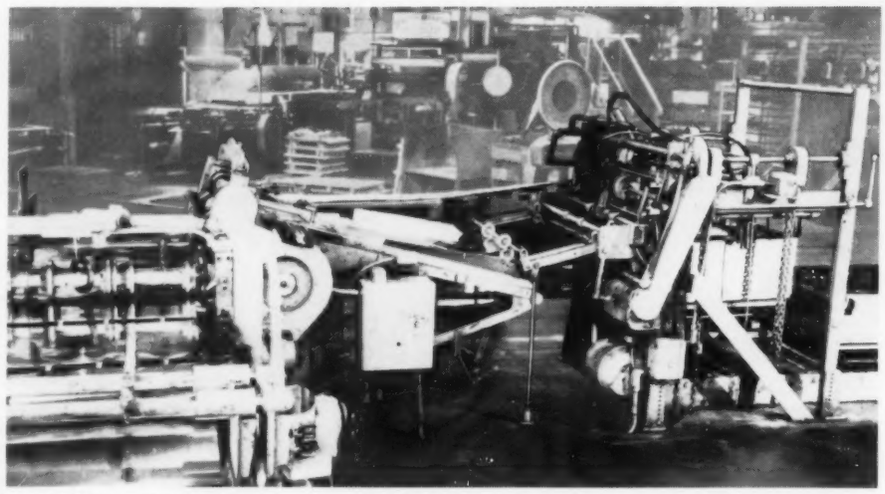

TC&I has installed five mechanized feeders to handle tin and black plate automatically.

and the new bundle rolled into place. The elevator then lifts the load to feeding position and as sheets are fed off, the pile automatically indexes upward. In feeding a sheet, suction cups lift the rear edge and a blast of air is blown between it and the pile to complete separation. Suction cups near the front edge then lift and pivot, advancing the sheet between friction rollers which forward it to the slitter conveyor. When a load has been depleted, the elevator is again lowered and a new load rolled into position.

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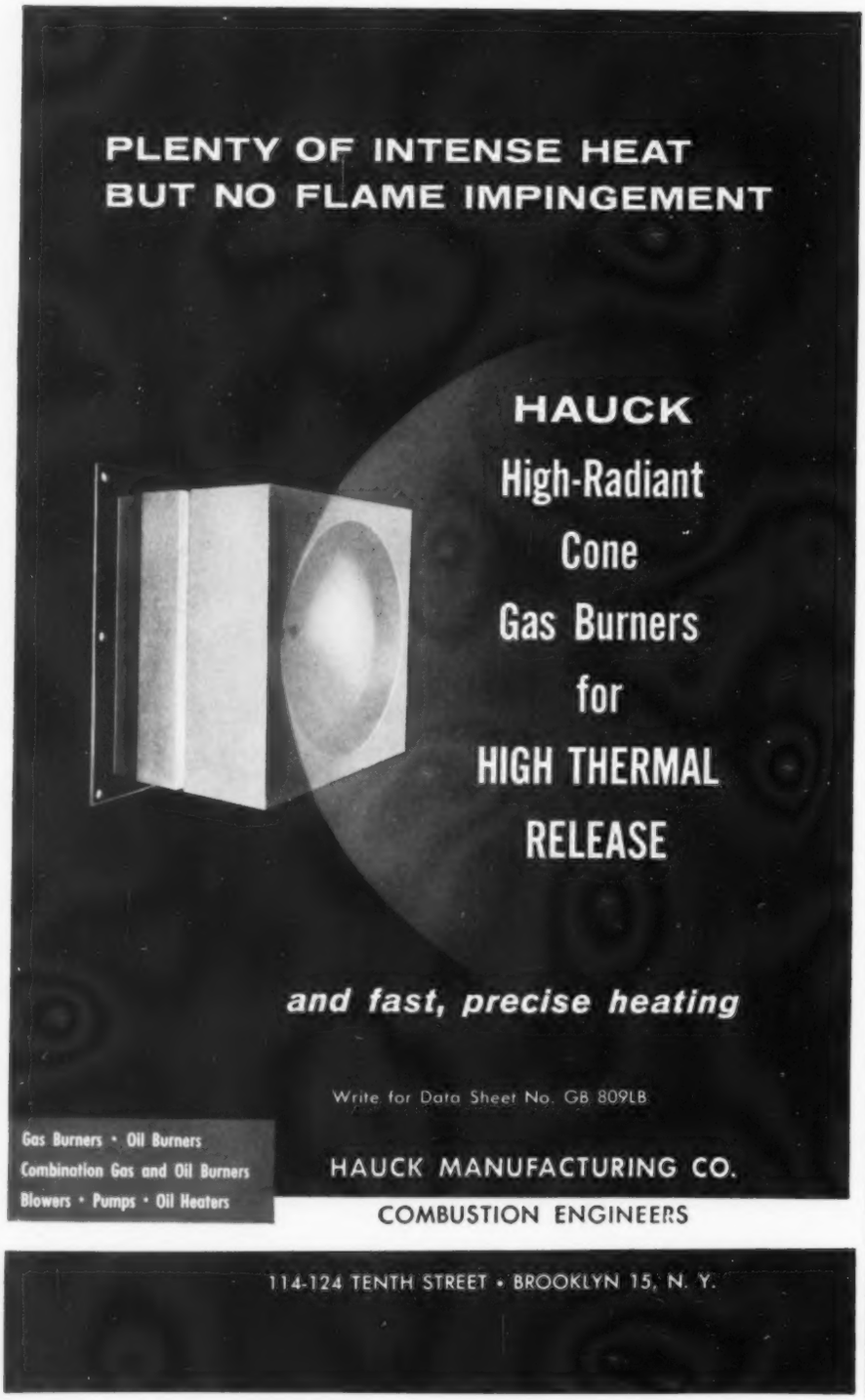
Book Reviews

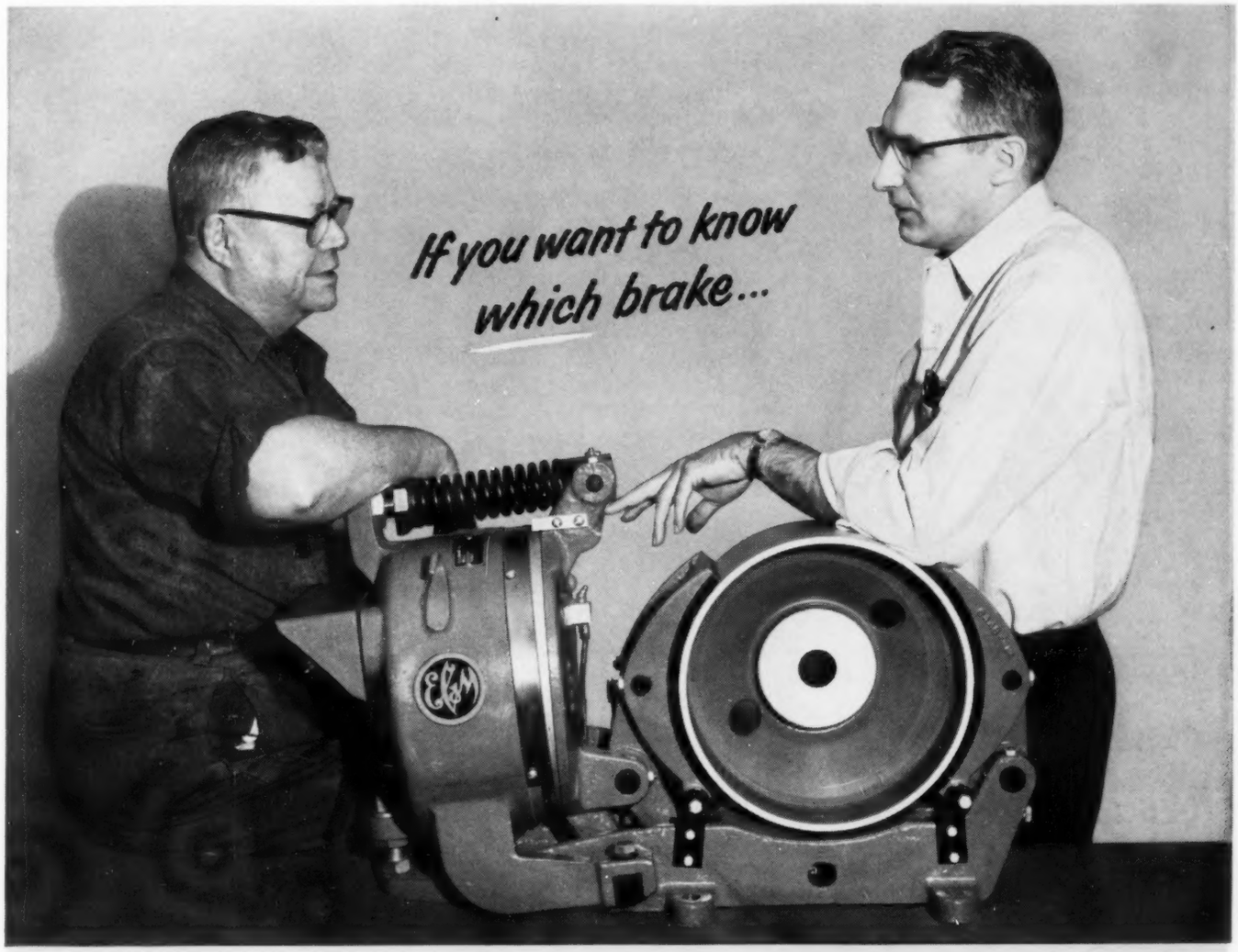
"Refractories Bibliography 1947–1956" has been recently published by the University of Oklahoma Press Publishing Division, University of Oklahoma, Norman, Okla. The book contains 1822 pages, 10½ x 7½ in., is cloth bound and sells for $7.50. This book has been compiled by The Joint Refractory Committee of the American Iron and Steel Institute and The Refractories Institute. The volume contains over 9500 references to the periodical literature and to U. S. and foreign patents on refractories relating to the raw materials, manufacture, properties and uses of refractories. Refractories in all phases of industrial use have been covered including glass industry refractories, petroleum industry refractories, foundry refractories and particularly refractories for the iron and steel industry. Developments in high temperature materials have been followed closely, excluding only the technology of whiteware. References have been carefully cross-indexed.

"Materials for Rockets and Missiles," by Robert G. Frank and William F. Zimmerman, has been recently published by the Macmillan Co., 60 Fifth Avenue, New York 14, N. Y. The book contains 124 pages, 5 x 7 in., is cloth bound, and sells for $4.50. This book presents typical engineering data on existing metal and ceramic materials and previews materials anticipated as being available within the next few years. It provides coverage of ceramics and high-temperature metallurgy and gives a cross section of materials available, with recommendation of the best material for each use. The book is amply illustrated with tables, charts, line drawings and photographs.

"1958 Book of ASTM Standards —Part 1—Ferrous Metals (Specifications)" has been published recently by the American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa. The book contains 1560 pages, 6½ x 9 in., is cloth bound and sells for $12.00. This volume of ASTM Standards contains 290 standards covering steel (both carbon and alloy); structural and rivet; boiler and pressure vessel steel plates; concrete reinforcement; commercial bar; hot and cold finished bars; welding electrodes, rods; bearing steel; sheet and strip; rails and track accessories; springs and spring wire; billets, forgings, blooms, axles; wheels and tires; castings; chain; bearings; bolting, pipe fittings; pipe and tubing; zinc- and lead-coated steel articles; wrought iron; cast iron; malleable iron; ferro-alloys; and metal powder products.

"1958 Book of ASTM Standards—Part 3—Methods of Testing Metals (Except Chemical Analysis)," has been published recently by the American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa. The book contains 980 pages, 6½ x 9 in., is cloth bound and sells for $10.00. This volume of ASTM Standards contains 119 standards covering metallography; tension; compression; bending; hardness; impact; magnetic particle testing; hardenability; grain size; creep; radiographic standards; linear expansion; inclusion





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content; heat treatment; thermal analysis; corrosion; weight thickness and uniformity of coatings; verification of testing machines; electrical and magnetic properties of metals; density; particle size; sampling; ultrasonic testing.

"Legal Aspects of Construction" by Walter C. Sadler has been recently published by the McGraw-Hill Book Co., Inc., 327 West 41st Street, New York 36, N. Y. The book contains 400 pages, 6 x 9 in., is cloth bound and sells for $8.50. This book reviews the rights and liabilities involved in the complex relations of the construction industry and is written as an aid toward avoiding legal entanglements and costly litigation. It traces the pattern of the business of contracting and examines the roles of the contractor, designer, owner and financier. A number of actual cases illustrating the adjudicated rights and liabilities of the parties-in-interest are discussed and coverage of boundary, lateral support and foundation rights and available remedies at law and in equity are included. The book is unique because it recognizes construction as a business involving the potential conflict of interests of contractors, subcontractors, sub-subcontractors and trade unions as well as factors of individual union contract provisions and federal, state, and local regulations and codes. A special feature is the coverage of the law "at boundary" in logical sequence and in unusual detail. Line drawings are abundantly employed to explain and emphasize the text.

"A Dictionary of Metallurgy" by A. D. Merriman has been recently published by the Pitman Publishing Corp., 2 West 45th St., New York 36, N. Y. The book contains 401 pages, 8½ x 11 in., is cloth bound, and sells for $25.00. The dictionary provides nearly 7000 definitions, there are 283 illustrations and 236 tables; included in the appendices are a table of common abbreviations and symbols, table of abbreviations used in foreign literature and a table of physical properties of metals. This detailed and comprehensive work includes specialized and recently introduced terms used in the atomic energy field. Ample cross references are included.

"Surface Defects in Ingots and Their Products" has been recently published by The Iron and Steel Institute, 4 Grosvenor Gardens, London, S. W. 1, England. The book contains 62 pages, is 8½ x 11 in., cloth bound and sells for 25*s* (15*s* to members of The Iron and Steel Institute). This Special Report No. 63 is issued as the second edition to Special Report No. 44, published in 1950. This report No. 63, in addition to the material covered in report no. 44 (which was prepared by the ingot surface defects subcommittee of BISRA, unifies the nomenclature applied to the more common defects), contains an important addendum illustrating surface defects in steel strip products. Included also are 134 half tone photographs illustrating the various types of defects, with each photograph accompanied by an explanatory text.

"Modern Foundry Practice" (Third Edition) E. D. Howard, Editor, has been published recently by the Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. The book contains 463 pages, 6 x 9 in., is cloth bound and sells for $15.00. This book is composed of

for intense concentration of heat...

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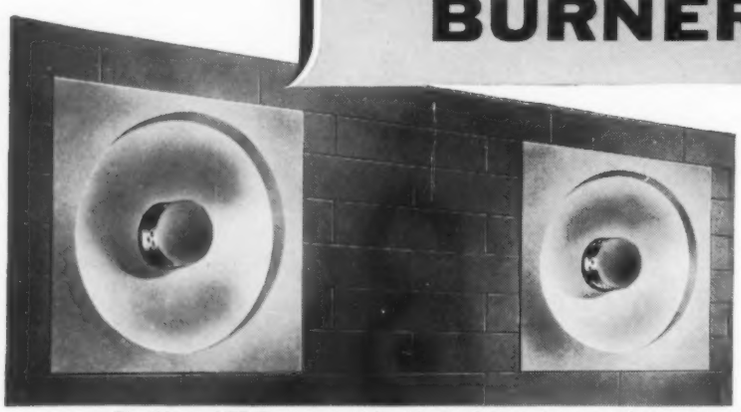

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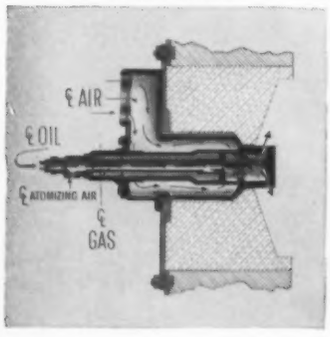

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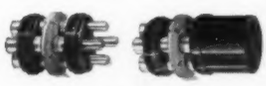

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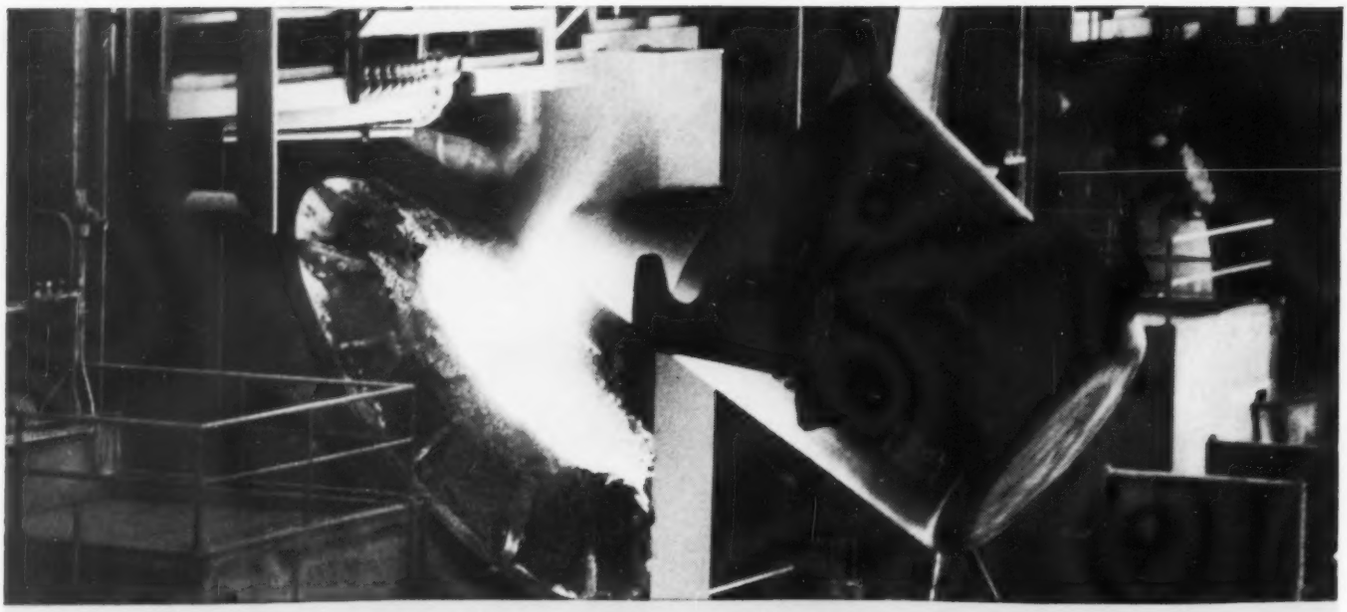

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contributions of 18 specialists, each chapter providing a self-contained and practical treatment of its subject. The style is simple and straightforward. Some of the new material of the third edition deals with the use of spheroidal-graphite cast iron, pressure-cast aluminum pattern plates, epoxy resin patterns, pop-off flasks and resin-bonded cores, and with recent developments in melting furnaces and sand technology. Also incorporated is an entirely new chapter describing shell molding and the carbon dioxide process. Several hundred drawings as well as photographs illustrate and explain the text.

"Problems in Engineering Structures" by R. J. Ashby and A. H. Chilver was recently published by the St. Martin's Press, Inc., 108 Park Ave., New York 17, N. Y. The book contains 168 pages, 6 x 8½ in., is cloth bound and sells for $4.50. This book covers elementary aspects of structural analysis. It includes a number of worked examples, in which sufficient explanatory matter is given to indicate the steps in the solution. This book is designed to cover the first two years of a University course, to provide the needed examples for students preparing either for undergraduate examinations or for the equivalent professional examination.

"Growth and Perfection of Crystals" edited by R. H. Doremus, B. W. Roberts and David Turnbull was recently published by John Wiley & Sons, Inc., 440 Fourth Avenue, New York 36, N. Y. The book contains 609 pages, 8½ x 11 in., is cloth bound and sells for $12.50. Presented in this volume are the proceedings of an international conference of crystal growth, held at Cooperstown, N. Y., August 27, 28, 29, 1958, sponsored by the Air Force Office of Scientific Research, Air Research and Development Command, and the General Electric Research Laboratory. Contained are up-to-date and pertinent reports and discussions on crystal phenomena, polymer crystallization and crystallization of simpler molecules. The book relates crystal growth in metals to that of growth in polymers and other types of solids; brings together literature on whisker phenomena dating back to 1574; summarizes present understanding of crystal growth; introduces the many advances made in the field since the Faraday Society Discussions of 1949.

"Elements of Physical Metallurgy" (second edition) by A. G. Guy was recently published by The Addison-Wesley Publishing Co., Inc. Reading, Mass. The book contains 528 pages, 6 x 9 in., is cloth bound and sells for $9.50. The book balances theory and practice and treats basic principles. It is adaptable to the science, engineering or metallurgy viewpoints. The new edition features the introduction of dislocation theory; addition of material on electron theory of metals in view of the increased importance of electric phenomena in semiconductors. A new chapter, "Phases in Metal Systems," to assist in the study of phase diagrams is also included. Other additions and revision of material were made as required to bring the book up to date. Photographs, line drawings, equations and tables are employed to explain and supplement the text.

(Please turn to page 234)

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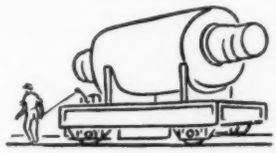

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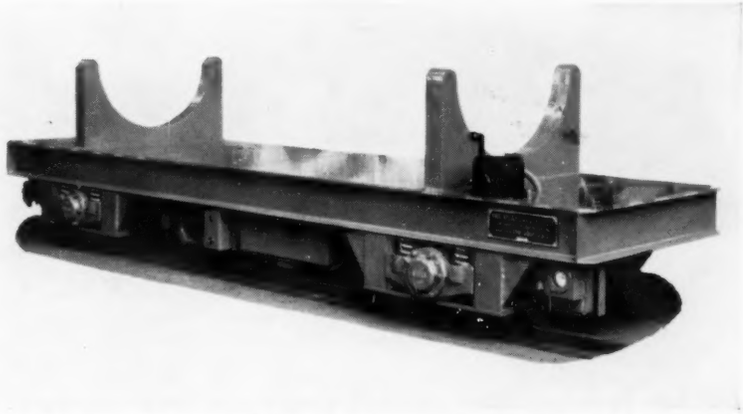

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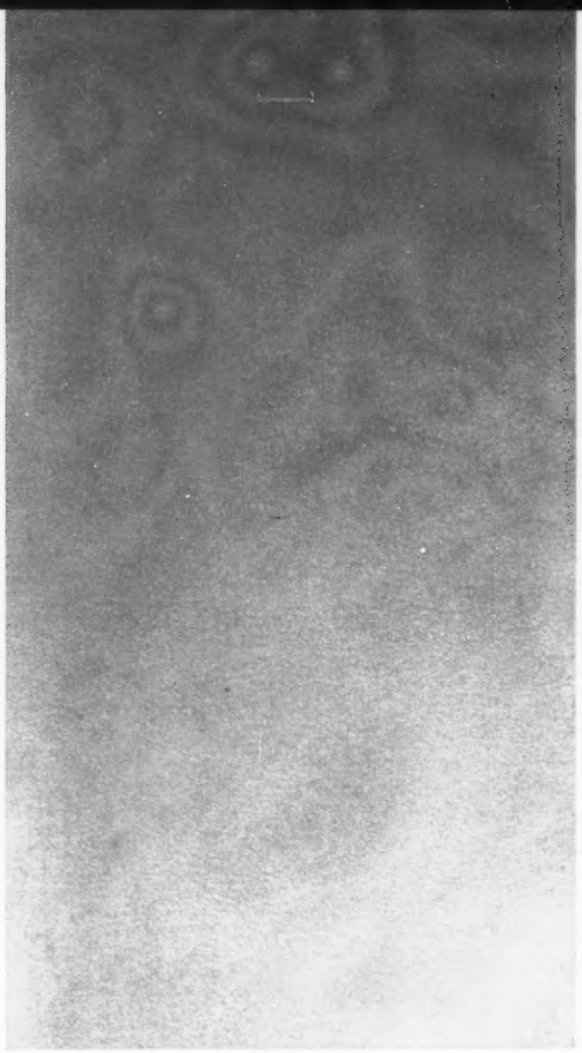

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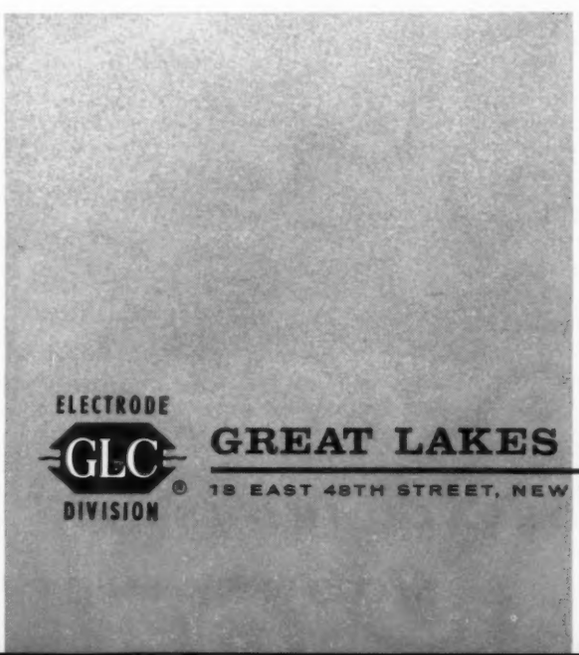

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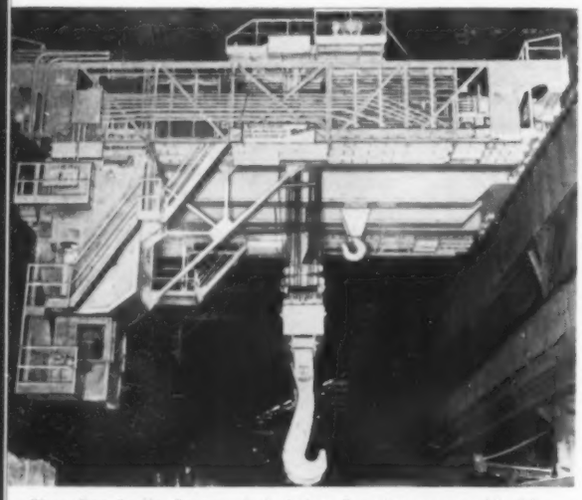

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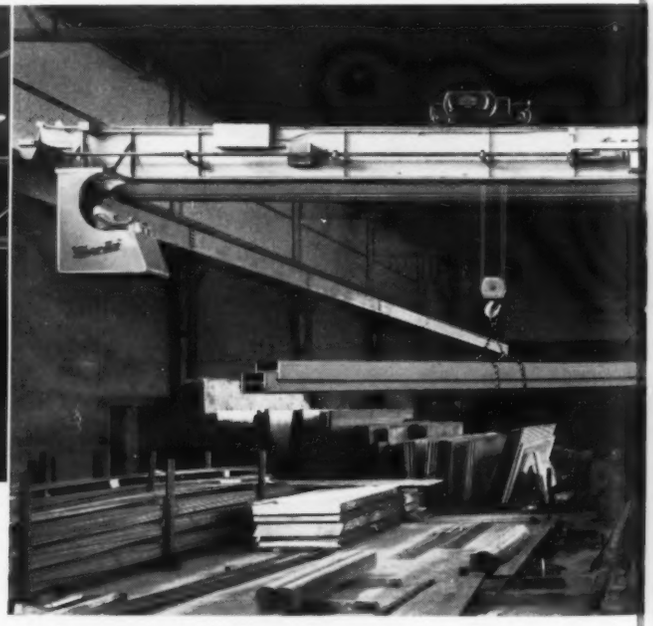

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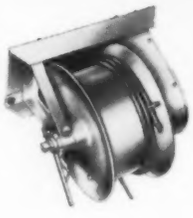

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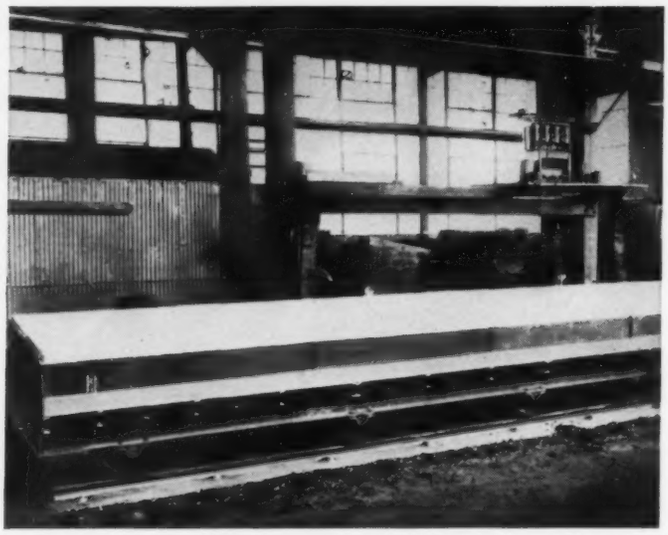
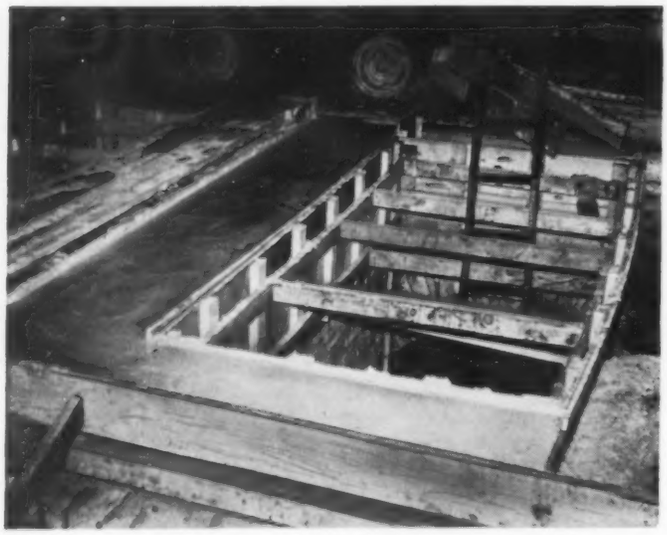


Heavy duty car top service requires a high strength castable. B&W Kaocrete-D is excellently suited for this service at temperatures to 2500 F. B&W Kaocrete-32 is recommended for service above this range.



B&W Kaocrete-32 has been cast to form the curb walls of a soaking pit. When mechanical abuse from ingots damages the curb, Kaocrete-32 has the necessary properties to localize the damage, thus maintaining the serviceability of the rest of the curb.

The castable lining of this aluminum reverberatory furnace must have unusually high strength to withstand the considerable physical abuse of charging, operating and cleaning, while resisting the penetration of the molten metal. Kaocrete-D is widely used in this application.

How B&W refractory castables solve abrasion problems

Refractory castable linings used in metal-working furnaces are often subjected to severe mechanical abuse. Scraping by hand tools, loading and unloading, and the action of the molten metal and particle-laden gases all affect the life of refractories. Among B&W's line of refractory castables are two that are particularly suited to withstand unusual abrasive conditions. They are B&W Kaocrete-D and B&W Kaocrete-32, both of which have been used successfully in many demanding applications.

Send for a copy of B&W Bulletin R-35A. It gives additional information on versatile B&W refractory castables.

R8O6

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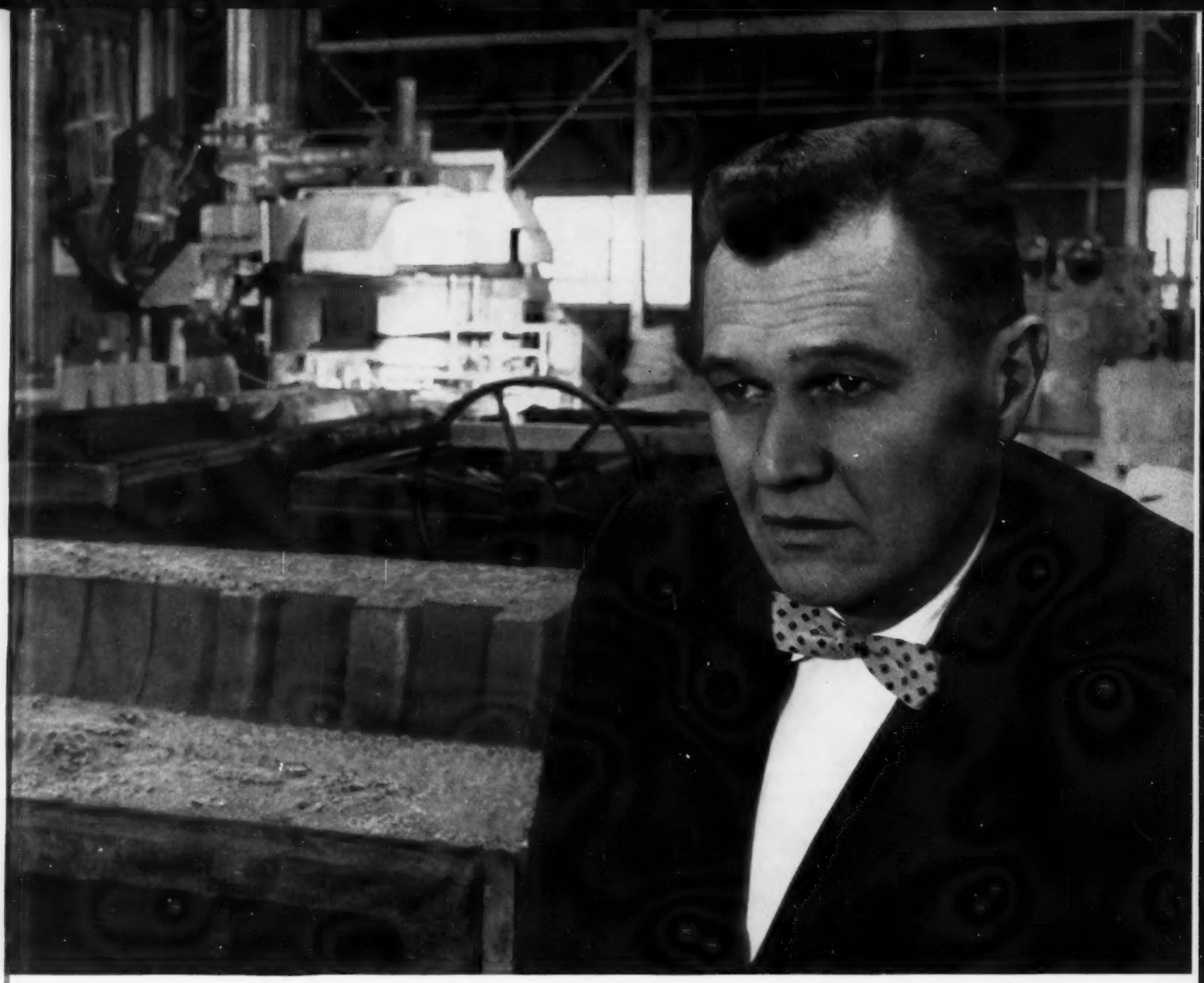

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Takes either 100 W or 150-200 W adapters. Ceiling, pendent, or bracket types available in a variety of hub sizes.

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Steel, with green porcelain enamel exterior; sized for 100 W, 150 W, or 200 W lamps. Snaps easily into position.

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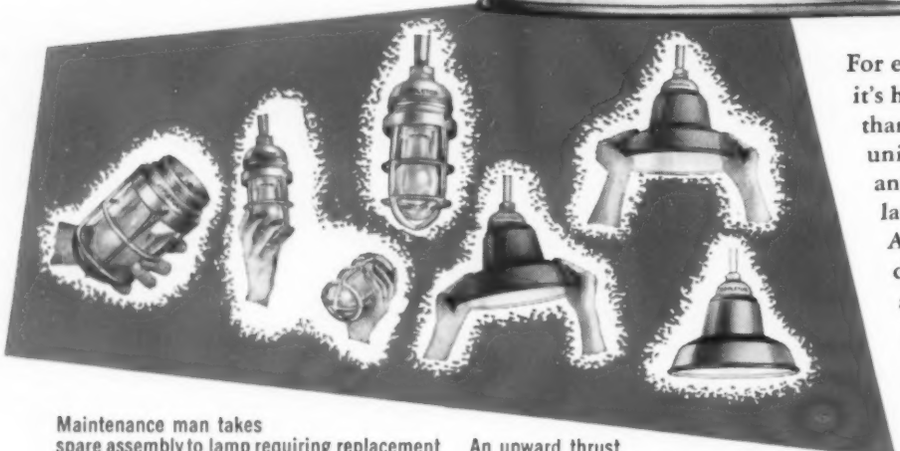

Maintenance man takes spare assembly to lamp requiring replacement or wattage change... removes lamp assembly ... screws fresh unit in place and the job is done! Higher wattages of 150/200 are interchangeable with 100 watt unit and can be used in same unilet body. (Die-cast aluminum guard turns counter clockwise to act as a tool for easy removal in relamping).

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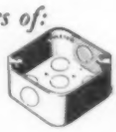

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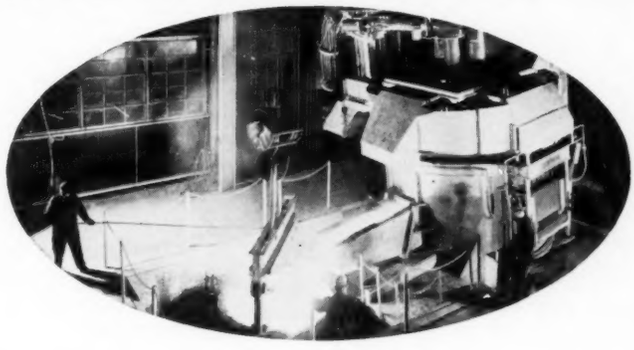

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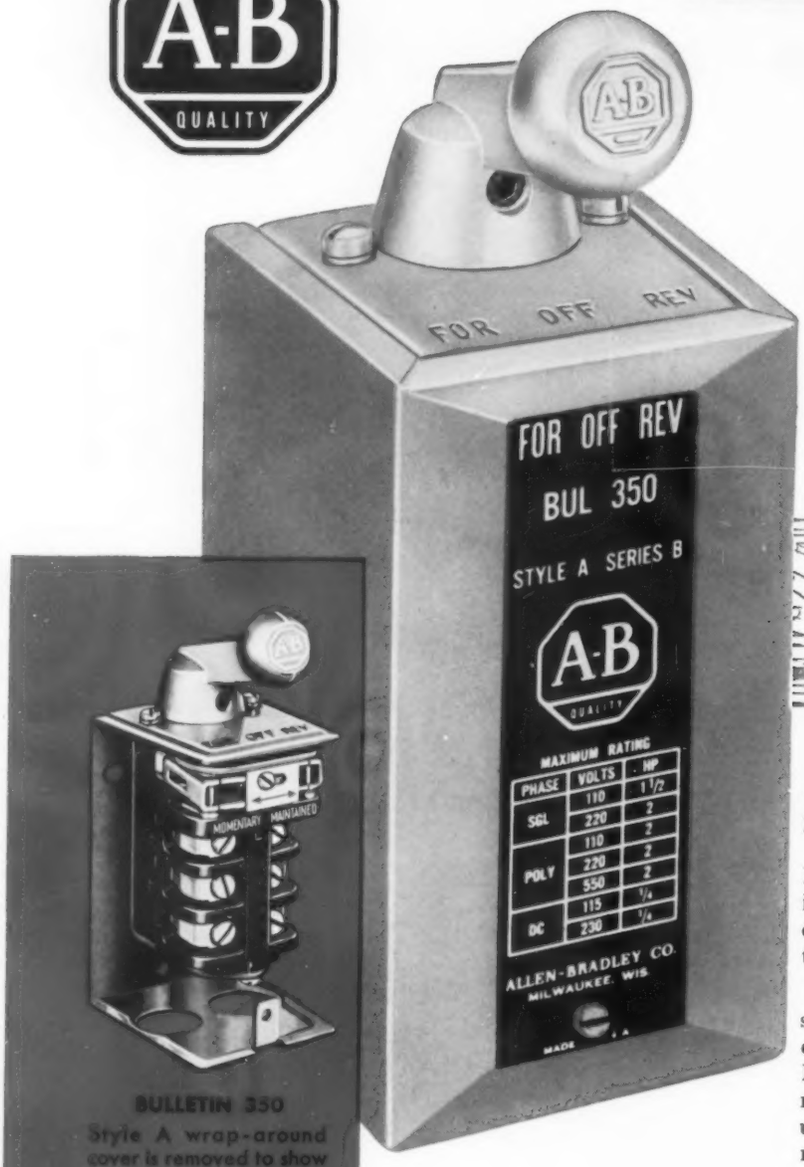
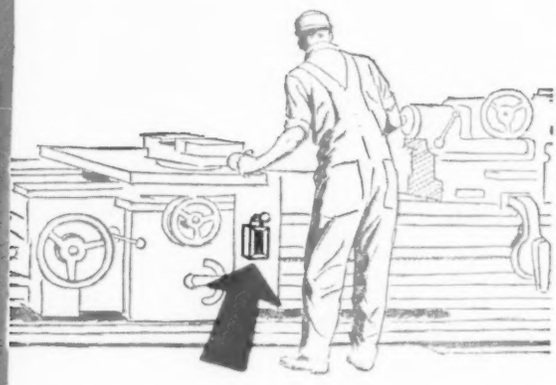


BULLETIN 350
Style A wrap-around cover is removed to show the readily accessible front wiring terminals. Max rating: 2 hp.



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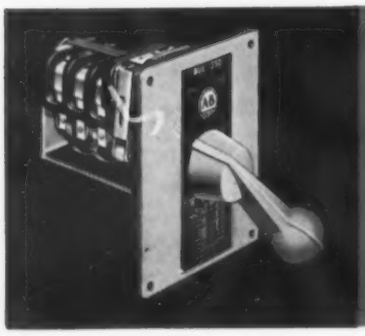
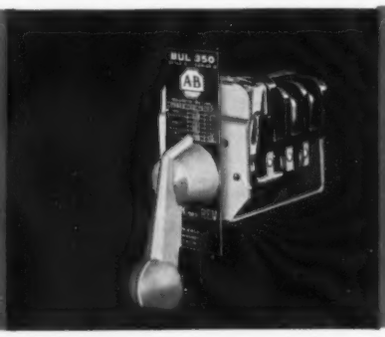


OILTIGHT CAVITY MOUNTING
A-B Style AF reversing switches can be furnished with sealed shaft and rubber-gasketed, oiltight cover for cavity mounting in a machine base.



PANEL MOUNTING
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Book Reviews

(*Continued from page 223*)

"Semiconductor Abstracts" (abstracts of literature on semiconducting and luminescent materials and their applications), Volume IV—1956 issue, edited by E. Paskell, has been published recently by John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. The book contains 456 pages, 8½ x 11 in., is cloth bound and sells for $12.00. This volume was compiled by the Battelle Memorial Institute, sponsored by the Electrochemical Society, Inc. The abstracts contained in the book are listed under the following classifications: germanium; silicon; carbon, selenium and other elemental semiconductors; intermetallics; sulphides, selenides and tellurides; oxides; halides; arsenates, phosphates, silicates and tungstates; organics; theory.

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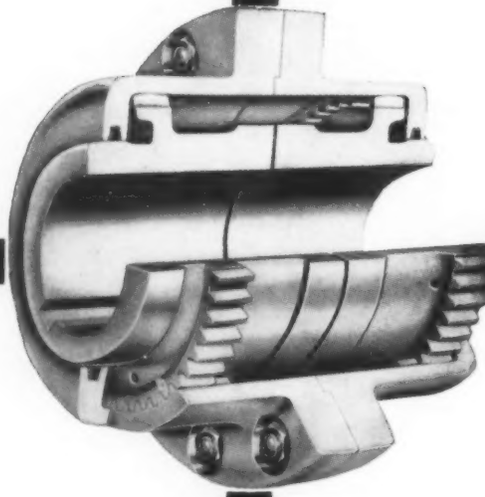

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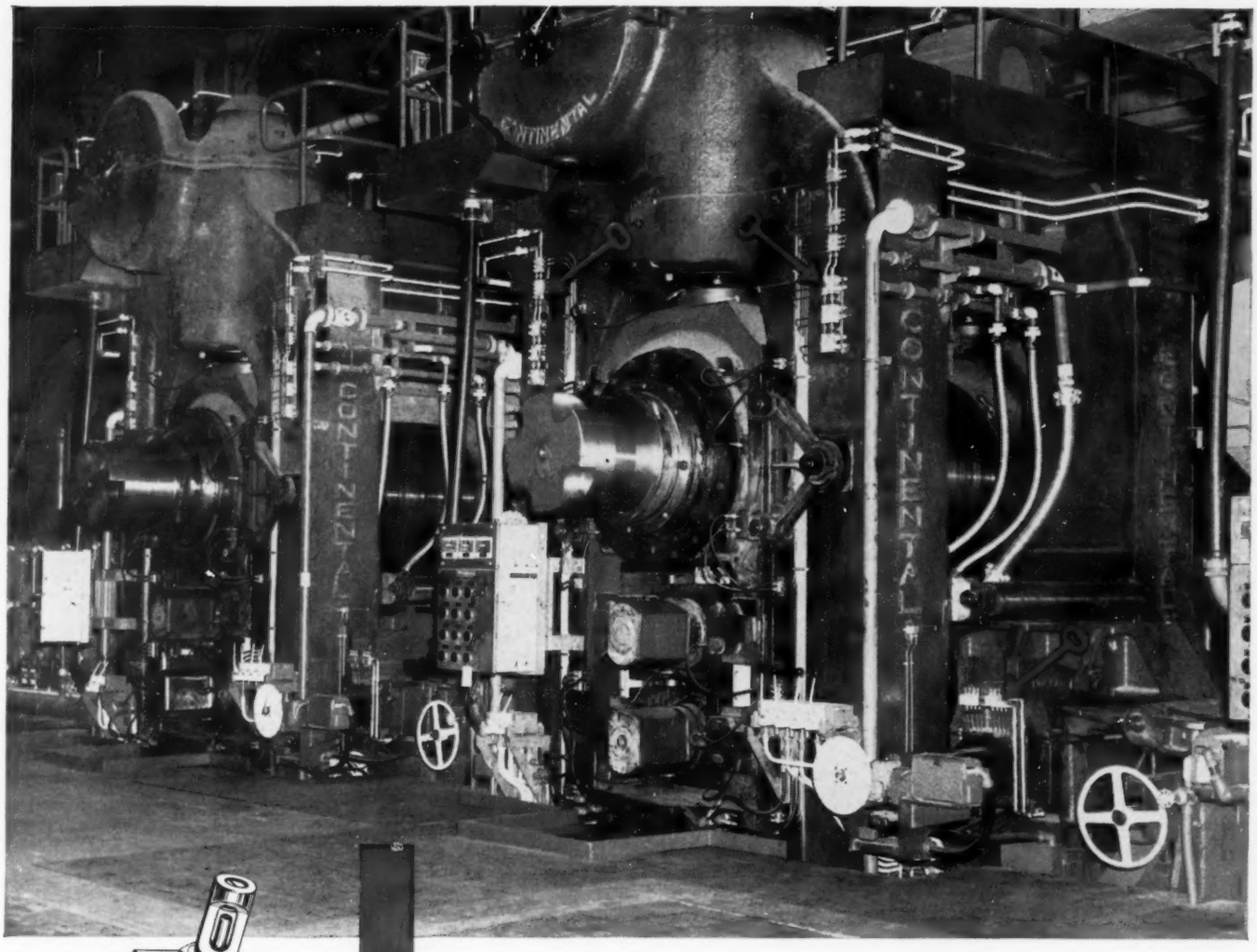

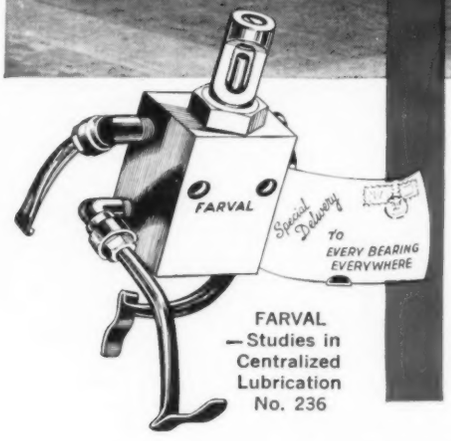

FARVAL
—Studies in
Centralized
Lubrication
No. 236

On new Hot Strip Mill, 10 Farval Systems protect 2023 vital bearings!

Bearing failure on this modern 5-stand, 54-inch semi-continuous hot strip mill will never be a problem. Mill operators know burned-out bearings can stop valuable output, sky-rocket production costs, idle expensive mill crews.

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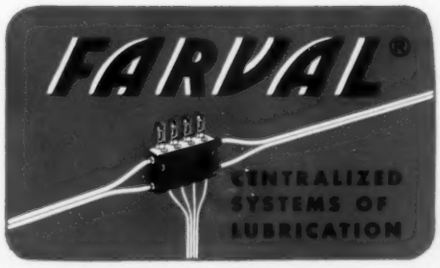

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